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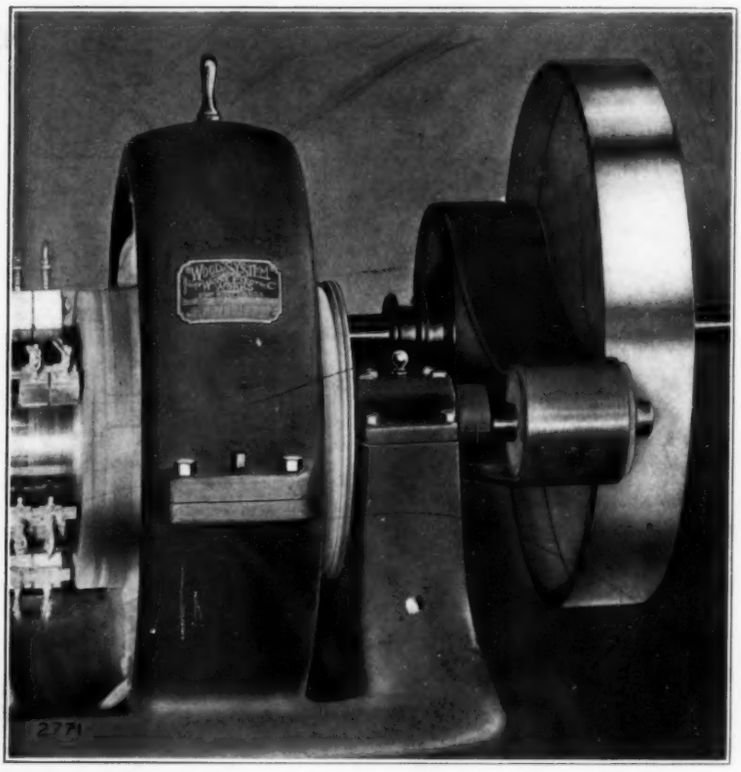

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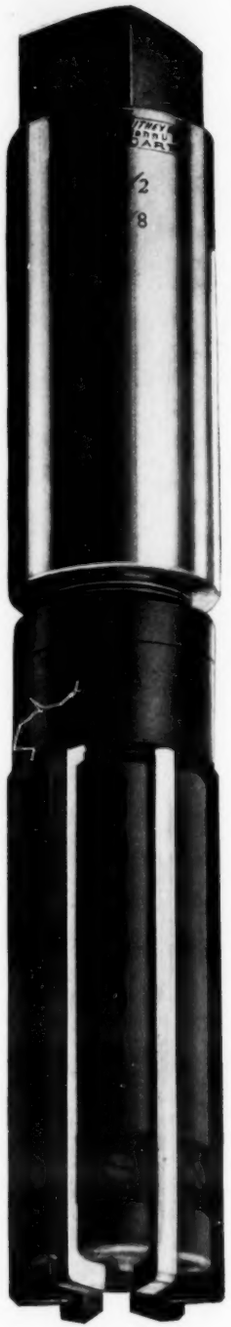

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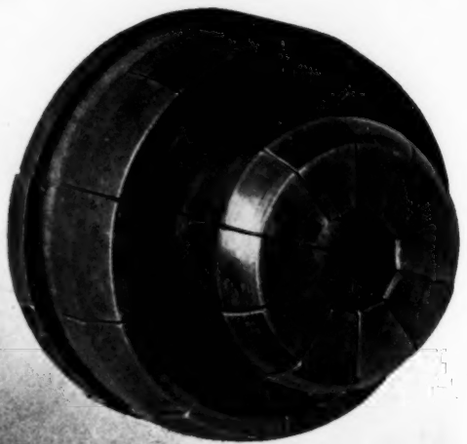

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AN INGENIOUS CALCULATING MACHINE

A Machine Which with Any Digit Multiplier Requires but One Turn of the Crank to Obtain the Product—Mechanism not so Complex as it Appears

BY HENRY J. KENNEDY

When a machine designed to perform the four elementary arithmetical operations with rapidity and accuracy, and capable of handling a pretty good-sized string of figures, is opened up so as to disclose its multiplicity of wheels, bars, cranks, rods, springs, pawls, framework, racks, and other mechanical elements of shining brass, steel, aluminum and iron, it looks to the uninitiated like a somewhat formidable task to unravel the complicated relations between all these parts, and to find out how they perform operations which upon an exhaustive study of the mechanical construction, or considering all the minor details, such as interlocking and safety devices. It should be remembered that the appearance of complexity is in part due to the repetition in the machine, several times over, of certain sets of parts, exactly alike and performing exactly the same functions in their particular places.

The standard size of the "Millionaire" calculating machine, shown in Figs. 1 and 2, is capable of multiplying together factors each having eight places of figures and giving a product having 16 figures. Larger and smaller sizes are also made. The largest one can reach 10 places each in the multiplier and multiplicand, and 20 places in the product. The machines can also add, subtract and divide.

FIG. 1. MILLIONAIRE CALCULATING MACHINE WITH 16 PLACES IN THE PRODUCT

are usually accomplished by the human mind in a still more mysterious manner. When one attempts to make clear the principles upon which such a machine works, it is difficult to avoid making the exposition as formidable in appearance, with its diagrams, details, numerous reference letters, etc., as the machine itself; in fact, of the two, the written article is likely to look less inviting. However, anyone who is interested in calculating machines, or who derives a pleasure from the mental exercise, will be well repaid if he has a little patience and follows through the movements in the ingenious machine which is the subject of this article; an effort will be made to make the principles clear, using a few simple examples, without entering

GENERAL VIEW OF THE MACHINE

Fig. 2 is a view looking down on top of the machine, showing all the handles for operating it and all the indicators of figures. Fig. 3 is a line drawing giving a similar view with reference letters. This is a portion of the machine with which everyone must become familiar, even if he desires only to operate the machine without understanding its internal mechanism. The following are the parts referred to:

K, the crank which sets the machine in motion after all the settings have been made for any desired operation. It should be stated that the machine illustrated is operated by hand power. One turn of the crank about its vertical axis, in a clockwise direction, is made for each operation, and the crank is normally in the position shown, which we shall call "at home." No other part should be moved or have its adjustment changed, except when the crank *K* is at home.

U, the regulator lever. There are four positions for this, and it is placed in one of the notches marked *A*, *M*, *D*, or *S*, according to whether it is desired to have the machine perform addition, multiplication, division or subtraction.

In the middle of the back portion of the cover is a row of slots extending from back toward the front, with figures from 0 to 9, and extending through each slot is a handle and pointer or "marker" *e*. In front of the slots are openings (*e'*) through which appear the figures corresponding to the positions of the markers, the object of these being to permit reading the amount set up on the markers in one straight line instead of a zigzag one. The markers *e e* are used to set the amount to be added in addition, the subtrahend in subtraction, the multiplicand, or the divisor.

H, which may be called the multiplication lever, is set in the position corresponding to the multiplier or quotient; in addition and subtraction it is placed at the figure 1.

We now come to the traveling parts. In the front portion of the cover there are long slots, through the back one of which appears a portion of the traveling carriage having openings *f f*. Through these are shown figures on the indicator dials, which show automatically the multiplier or the quotient. This is a convenience, not an absolute necessity, for the operator could carry these figures in his head, or write them down with a pencil. It is a useful check upon the movements he has gone through in operating the machine.

Showing through the front slot is a very important row of dials, viz., the result dials *g g*. Upon these appear the amount in addition, the remainder in subtraction, and the product in multiplication. In division the dividend is set up on them, usually by turning the stems of the dial spindles individually by hand.

W is a knob for shifting the carriage by hand.

C and *R* are the "effacing knobs," by

the sliding of which to the right, the dials *f f* and *g g*, respectively, are all set to 0.

Between the individual dials of the three rows *e'*, *f* and *g* are holes for removable studs, used for marking the decimal points.

THE INTERIOR

Upon opening the machine up, we find in the front the traveling carriage, upon which the *f f* and *g g* dials are mounted, two shafts 2 and 3 with gearing, clutches, cams, etc. Fig. 4 is from a photograph showing the mechanism left after removing the top plate and the markers *e e*, the front, back and ends of the case, the traveling carriage and the front shaft 3. In the back left-hand corner is the "pusher frame," the position vertically of which depends upon the position of the lever *H;* this frame has a small transverse motion produced by the cam 4 on the left-hand end of the shaft 2, and has a stroke back and forth produced by its connection to a cross-head 5, which in turn is caused to reciprocate by the crank 6 and connecting rod 7 in the right-hand back corner. (Refer also to the diagram, Fig. 6.) Lying between two long bars 8, which connect the cross-head 5 to the pusher frame, is a group of nine sliding racks *Z;* and back of them one fixed rack. These racks all have the same number of teeth, and with the exception of the fixed one are subject to varying amounts of travel by action of the rack-pusher plates. There are nine horizontal rows of pusher plates of varying lengths, as shown in Figs. 6 and 7.

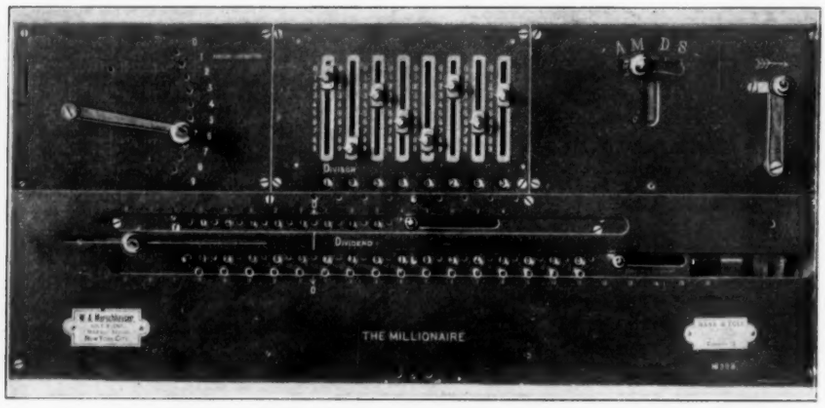


FIG. 2. VIEW SHOWING TOP OF THE 8-PLACE FACTOR, 16-PLACE PRODUCT, MACHINE

In the middle of the length of the machine, just above the racks, are several horizontal square shafts 9, having pinions 10 which slide on them under the control of the markers *e e*, so that any of them may mesh with any one of the racks. In Fig. 21 is shown one of the shafts with its pinions. When the markers *e e* are set at 0, the pinions are in mesh with the fixed rack, which serves merely to hold them in their normal positions. The shafts have at their back ends rose-wheels with ten notches, and pawls, so as to make them stop and hold them at the proper divisional points of their revolution. To the left of the square shafts is a round shaft 11 (Fig. 4), with a pinion always in mesh with the No. 1 rack, that is, the sliding rack farthest back. This shaft is for driving the indicating dials *f f*, as will be explained later. The front ends of the shafts extend underneath the carriage, where they serve to drive the dials of the carriage by means to be explained later.

At the right-hand end of the machine is a vertical shaft carrying the hand crank *K*, which, as already stated, drives the whole machine. The method by which it drives the horizontal axis crank 6 and connecting rod 7 are pretty well indicated in Figs. 6, 9 and 19. The bevel gears by which it drives the shaft 2 are well shown in Figs. 4, 8 and 19. The method by which the shaft 3 running along just inside the front of the box is driven is apparent in Fig. 8.

The following table is given for reference, to make it easier to understand the relative motions; it shows the number of revolutions made by the principal shafts to one revolution of the crank *K*, which may be called one cycle of movements:

Mark.	Direction of Shaft.	Number of Revolutions per Cycle.
K	Vertical	1
1 (Crank Shaft).	Horizontal	2
2 (Helical Cam Sh't)	"	1
3 (Cam-drum Sh'ft)	"	2

The effect of the variations in the position of the regulator lever *U* and the mechanism which it controls will be described later.

Fig. 5 shows the traversing carriage and the cam-cylinder shaft 3 removed from the machine. The openings for the *f f* and *g g* dials are visible in the top plate, also the projecting "effacing knobs" *C* and *R*, and the carriage-shifter knob *W*. At the left is a bell which rings when the machine has reached its limit or when a mistake is made in division, and in front on the shaft 3 is the cam cylinder, the object of which is to "carry the tens" in the operation of the *g g* dials, as will be explained later.

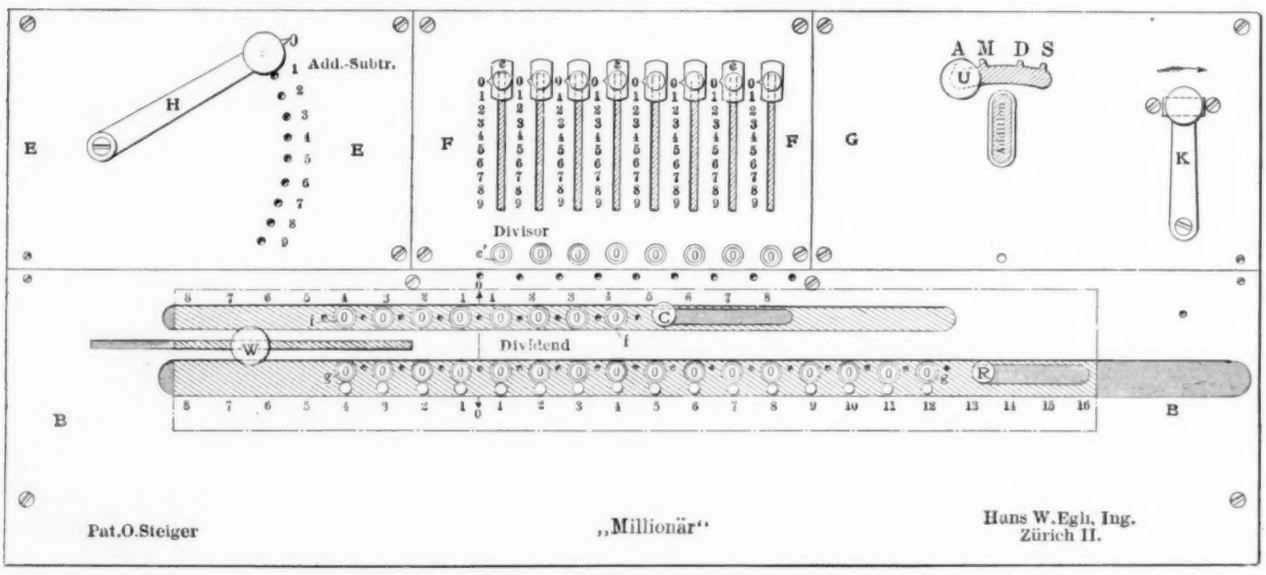


FIG. 3. PLAN OF TOP OF MACHINE, SHOWING OPERATING HANDLES, INDICATING DIALS, ETC.

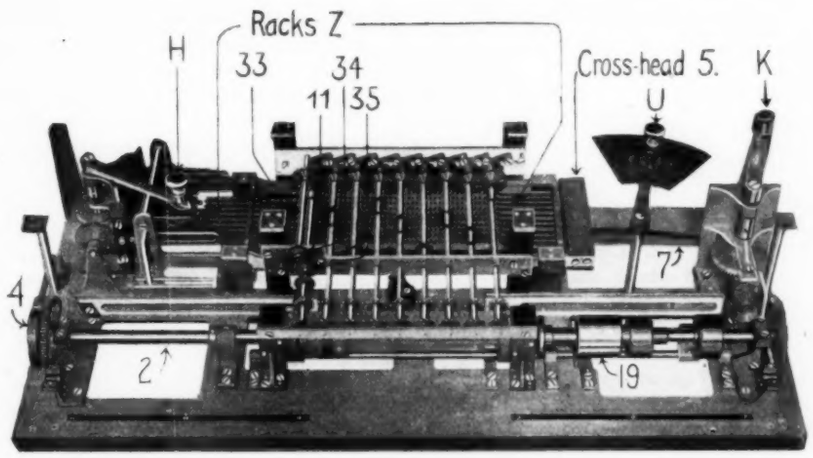


FIG. 4. BASE-PLATE AND MECHANISM; TRAVELING CARRIAGE AND FRONT SHAFT REMOVED

THE PRINCIPAL GROUPS OF MECHANISM

It is believed that the action of the mechanism can be most readily made clear by taking up one group at a time and examining its performance during the different arithmetical operations.

The principal groups of mechanism are partly shown diagrammatically in Fig. 6 and are, first, a mechanical multiplication table, which is one of the most prominent features of the machine, and which consists of a series of vertical notched or stepped plates, here called rack-pusher plates; for each multiplier there are two plates—one for the tens and one for the units—which act one after the other. The range of this table is from 0×0 to 9×9, inclusive. This part of the mechanism also includes the means for giving the required motions to the pusher plates. Second, a transferring mechanism, which transfers the partial products to the third mechanism. The second consists of the racks, pinions and square shafts. The third is the combining and registering mechanism, which is mostly carried by the sliding carriage. This takes the partial products from the transferring mechanism and combines them so that the result is exhibited on a row of dials. There is, furthermore, the indicating mechanism which has already been referred to as a useful auxiliary.

THE RACK-PUSHER PLATES

Fig. 7 is a series of horizontal sections through the battery of pusher plates, which are arranged vertically in pairs, the tens plate of each pair being toward the back of the machine, and being indicated on the diagram by cross-hatching. The

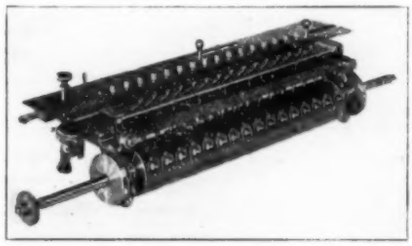


FIG. 5. TRAVELING CARRIAGE AND FRONT SHAFT 3

units plate of each pair is toward the front of the machine, and is indicated by being left without section-lining. The tens and units notches for each product are on the same level. It will be seen that at some levels the plates are in some places notched back to the datum line, so that no tongues project; for instance, in the top row, where the multiplier is one, there are no tens tongues at all, which of course follows from the fact that the highest possible product here is $9 \times 1 = 9$, hence no tens are required. The rack pushers are all fixed together like one body, and make two outward (toward the right-hand end) strokes per cycle. During the first stroke the tens plates are opposite the racks and push them, if there is any pushing to be done; during the second stroke the battery of pushers is shifted over by the cam 4, Figs. 3 and 8, so that the units plates come opposite the racks and push them. The shifting is so timed that it occurs when the pushers are not touching the racks. The mechanism by which the crank *H* regulates the hight of the battery of pusher plates and therefore the level (Fig. 7) which comes into action with the racks, is partly visible in Figs. 4 and 9, consisting of bevel gears and two pinions on a horizontal axis, driving two parallel vertical racks. A horizontal notched locking bar is operated by the motion of the cross-head 5, Fig. 9, sliding through the notches in a vertical square-toothed rack, which rises and falls with the pusher frame. This prevents vertical motion of the pusher frame except when the crank *K* is at 0 or 180 degrees; of course there is very little chance of an attempt being made to move the handle *H* in the latter case.

It is believed that the explanation of the action of the pushers will now be intelligible. This will be followed by tracing the action through the racks, pinions, and square shafts to the carriage mechanism, until the result is shown on the dials *g g*.

As may be seen from Fig. 2 and Fig. 3, when it is desired to perform addition or subtraction the handle *H* is placed at the No. 1 hole, so that the battery of rack pushers is in the next to lowest position. We will speak of the two outward strokes which occur in the first and second revolutions of the crank 6 as the "first push" and the "second push," respectively.

ADDITION

First push—The upper row of pushers, shown in Fig. 7 as the one-multiplier row, is opposite the racks. As there are no tens tongues at this level, no racks are pushed.

Second push—The pusher frame is

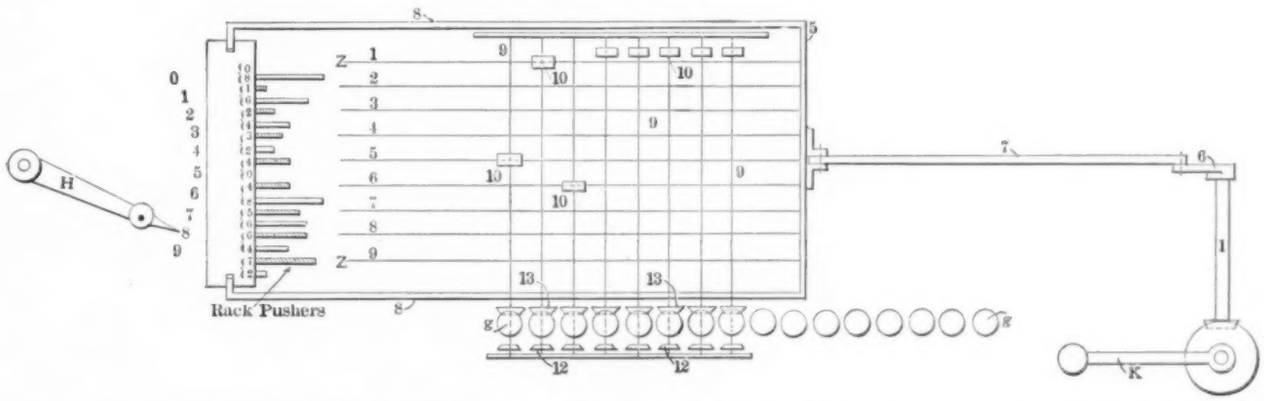


FIG. 6. DIAGRAM REPRESENTING THE MULTIPLICATION RACK-PUSHERS (AT "X 8 LEVEL"), THE TRANSFERRING MECHANISM, AND THE BEVEL-GEARS OF THE REGISTERING MECHANISM

shifted over by the cam 4, Fig. 8, and the units pushers or tongues are brought in line with the racks, and

No. 1 rack is pushed to the right one tooth,

No. 2 rack is pushed to the right two teeth,

No. 3 rack is pushed to the right three teeth,

etc., to

No. 9 rack is pushed to the right nine teeth.

The racks remain in these positions until the cross-head 5, upon its return motion to the left, hits the right-hand ends of the racks, starting with No. 9, which is sticking out the farthest, and pushes them all back to their normal positions.

ACTION OF THE RACK PINIONS, SQUARE SHAFTS, AND THEIR BEVEL GEARS IN PERFORMING ADDITION

When by means of the markers *e e*, the pinions 10 have been placed in engagement with any of the moving racks, they are, on the second push, caused to rotate as many teeth as the racks with which they meshed have slid. This, of course, causes the square shaft 9 and the two miter gears on it (see 12 and 13, Figs. 6 and 10) to turn the same amount.

Normally, the vertical miter gears 12 and 13 are not in engagement with the horizontal miter gear 14 on the *g* shaft which lies between them. However, in addition or multiplication, they are caused, twice in the cycle, to slide forward on the square shaft, that is toward the front of the case, so that the back miter gear 13, meshes with the horizontal miter gear 14, as indicated in Fig. 10. In performing addition, there is during the first half of the cycle, as explained under pusher-plate action, no rack movement and hence no rotation; during the second half the rotation which the square shaft receives from the rack is communicated to the vertical shaft and causes an increase in the number shown at *g g*. Before the backward movement of the racks and square shafts, the miter gears have been returned to their normal positions and thus thrown out of mesh with the horizontal miter gear 14, so that the backward motion is not communicated to the dials *g g*. This sliding motion of the miter gears on the square shafts is produced by a brass bar, which lies between them and which makes two "round trips" per cycle, being moved by two curved iron arms which reach up around the shaft 2. These arms are mounted on a horizontal rock shaft 15, which runs along the floor of the machine below the carriage but does not slide with the carriage. At its right-hand end this rock shaft carries a rocker arm 16, Fig. 10, with two cam rolls. For addition and multiplication the one on the left is in engagement with the cam 17; for division and subtraction the one on the right is in engagement with the cam 18, and these two cams are shifted along the shaft with the clutch 19, by the movement of the lever *U*. The left-hand elevation in Fig. 10 is an end view of the cam 17 and indicates the direction of engaging movement of the miter gears 13, when addition or multiplication is being performed. It will be remembered that the shaft upon which these two cams are mounted makes one revolution per cycle, or in other words, its motion is synchronous with that of the hand crank *K*. During the first quarter turn of *K*, the gears 13 and 14 are brought into engagement by the action of the cam shown; during the next quarter turn the cam causes them to be disengaged; and during the third and fourth quarters the meshing and unmeshing is repeated.

During division or subtraction the two lever arms make two round trips per cycle in the opposite direction, because this time they derive their motion from the cam 18. Thus it is, this time, the front miter gears 12 which are brought into mesh with the horizontal miter gears 14, so that the turning of the dials *g g* is in the opposite direction, or backward, during division or

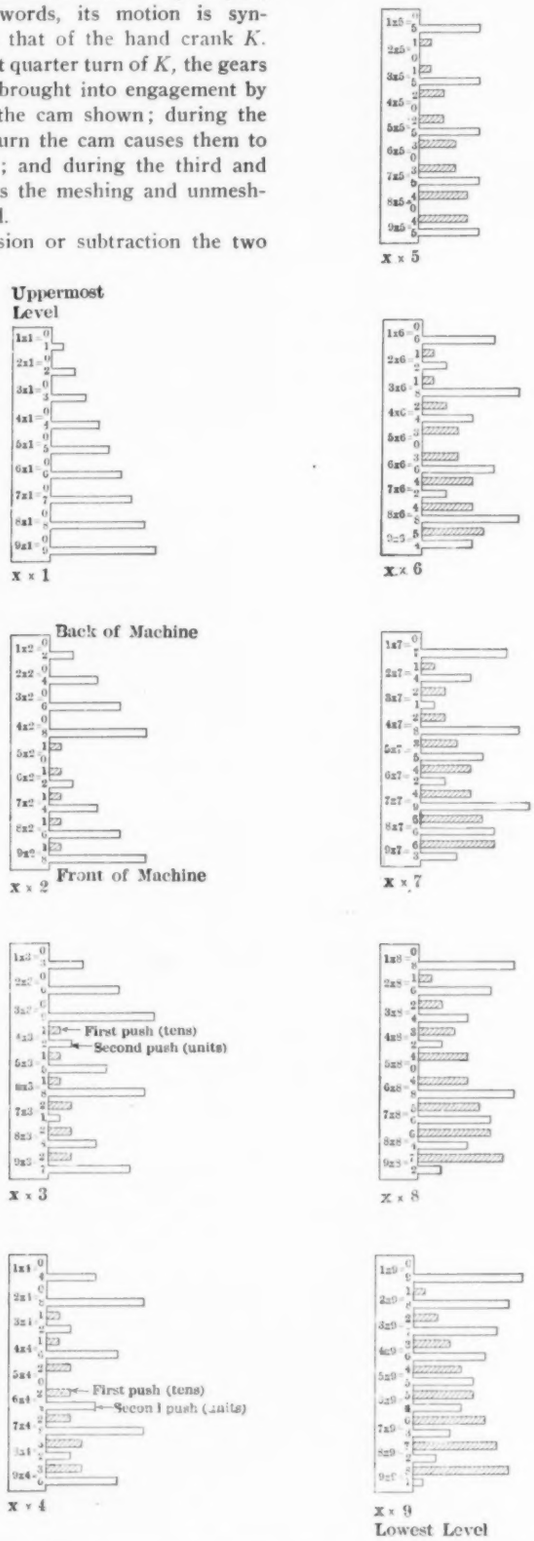


FIG. 7. HORIZONTAL SECTIONS (LOOKING DOWNWARD) THROUGH THE RACK-PUSHERS AT THE DIFFERENT LEVELS CORRESPONDING TO THE DIFFERENT DIGIT MULTIPLIERS

subtraction. The second elevation in Fig. 10 is an end view of the cam 18, which produces this action. It will be noticed that the rolls of the two cams are not in line with each other.

ACTION OF THE PUSHER BARS AND SUCCEEDING PARTS IN SUBTRACTION

The minuend is indicated on the *g g* dials, either having remained there from some previous operation or being placed there by turning the projecting handles or stems on the *g g* shafts. The subtrahend, or number to be subtracted, is indicated by the markers *e e*, which slide the pinions on the square shafts. The carriage is placed to bring the decimal points correctly in line one above the other. The lever *U* of course is at "S."

Example: $412 - 46 = ?$ We will set the 412 on the third, fourth and fifth *g g* dials, counting from the left, and the 46 on the third and fourth square shafts, so that the third pinion meshes with the No. 4 rack and the fourth pinion with the No. 6 rack. The pushers are raised to No. 1 (addition and subtraction) notch. Upon turning the crank *K* the racks are pushed exactly as in addition, but since it is the miter gears 12 that are in mesh this time, as described in the preceding section, the dials *g g* are turned backward, the decimal counting mechanism being thrown into action at the change from 0 to 9, so that the remainder near the end of the operation reads 476, which is changed, when the cams on the cam drum 21 come around and hit the two pins 30 corresponding to the third and fourth *g g* dials, to 366. The action of this decimal-counting mechanism or ten-carrying mechanism will be explained in detail later on. The *f* dial shows "1."

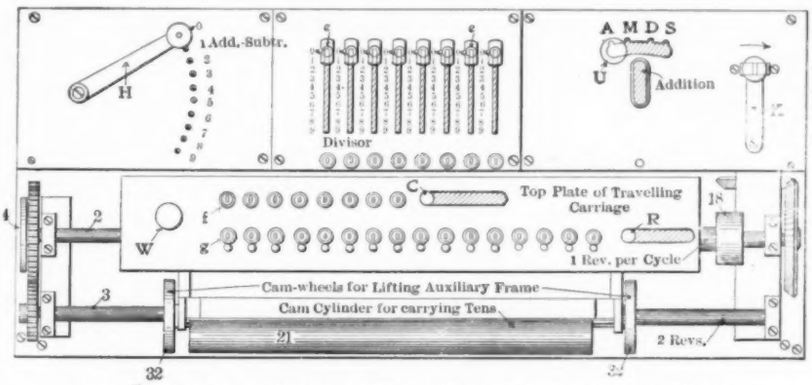


FIG. 8. PLAN OF MACHINE AFTER REMOVAL OF TOP PLATE B, SHOWING TRAVELING CARRIAGE

ACTION OF THE PUSHER BARS AND SUCCEEDING PARTS IN MULTIPLICATION

To illustrate the working of the machine, we will start at the simplest possible case and advance to more complicated ones, all of them, however, much simpler than the machine would ever be used for, but being sufficient for this purpose.

Example: 1×1. Carriage at extreme right. Left-hand sliding pinion in mesh with rack 1. Pushers raised to second notch on the vertical rack. During the latter part of the first half-revolution the carriage moves one step to the left, as explained under carriage travel.

During the second half-revolution the pushers are shifted over by the cam 4, Figs. 4 and 8, so that the top row of pushers is in line with the racks, and the racks are pushed just as in addition or subtraction, viz.:

Rack 1 moves to the right one tooth,

Rack 2 moves to the right two teeth, etc., to

Rack 9 moves to the right nine teeth.

After the movement of the carriage, the second *g* dial is in line with the left-hand square shaft, so this dial is rotated to 1, which is the product (see "Action of the Rack Pinions, Square Shafts, and their Bevel Gears."). Also, the first or left-hand *f* dial is brought in line with the round shaft (see "Drive of the Dials *f f*"), and it is rotated one unit during the outward stroke of the rack 1, thus indicating the multiplier.

Example: 1×2. Everything as before, except that the pushers are raised up to the third (or "2") notch. This

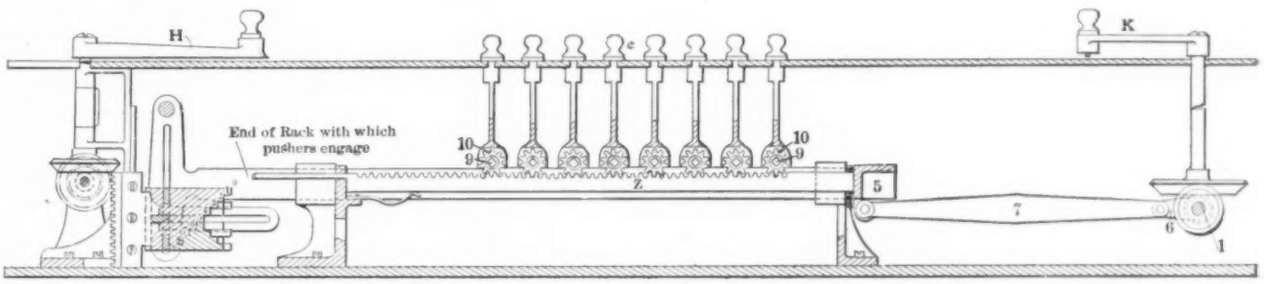


FIG. 9. LONGITUDINAL SECTION NEAR NO. 9 RACK, SHOWING PUSHERS, RACK, CRANK, AND CROSS-HEAD, SQUARE SHAFTS AND PINIONS, MARKERS, ETC.

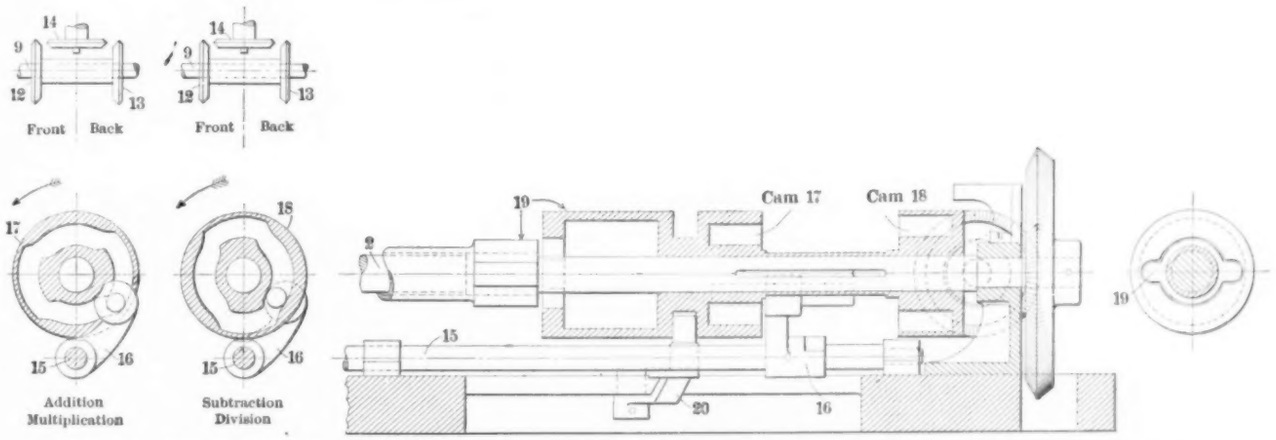


FIG. 10. CLUTCH CONTROLLING CARRIAGE TRAVEL; AND CAMS WHICH SLIDE THE BEVEL GEARS ON THE SQUARE SHAFTS

time something happens on the first half revolution, or first outward stroke of the pushers. The racks Nos. 5 to 9 inclusive are pushed one notch to the right *before* the carriage moves, which is therefore equivalent, in its effect on the reading of the result dials, to ten *after* the carriage moves. However, as no pinions are meshing with these racks (the multiplicand being only 1) this does not have any effect on the dials. The carriage, of course, traverses one pitch distance as before.

On the second half revolution, the pushers have shifted over horizontally backward, the second row, counting downward, coming into action.

Rack No. 1 is pushed two notches to the right, causing the left-hand *f* dial to be turned to 2, thus indicating the multiplier. Simultaneously, the second *g* dial from the left is turned to show the figure 2 through the round opening above it, thus indicating the product. The following are the amounts of movements of the racks at the second push:

No. 1	2	notches		
2	4	"		
3	6	"		
4	8	"		
5	0	"	which, added to the equivalent ten of the previous push, gives	10
6	2	"		12
7	4	"		14
8	6	"		1
9	8	"		1

Hence it will be seen that the aggregate equivalent movement of any rack, when the multiplier is 2, is twice as many teeth as the number to which that rack corresponds.

Rack No. 1 being the only one meshing with one of the pinions on the square shafts, that pinion is turned three notches, and the corresponding *g* dial shows the figure 3 as the product. The *f* dial also shows 3 as the multiplier.

A little study of a table like the above throws much light on the principle of the machine.

Example: 1×9. Compare the table with the last or bottom row of pusher tongues in Fig. 7.

Rack Number.	First Push.	Equivalent.	Second Push.	Aggregate.
1	0	0	9	9
2	1	10	8	18
3	2	20	7	27
4	3	30	6	36
5	4	40	5	45
6	5	50	4	54
7	6	60	3	63
8	7	70	2	72
9	8	80	1	81

As before, the second *g* dial shows the product, in this case 9, and the first *f* dial shows the multiplier 9.

Example: 2×1. Left-hand pinion in mesh with rack 2. Pushers raised up to second ("1") notch. First half-revolution, no racks pushed; carriage shifts over one step. Second half-revolution, action of racks same as in example 1×1, that is, each one is pushed to the right as many teeth as the number to which it corresponds. Rack 2 is therefore moved two teeth, and turns the pinion two teeth, which turns the dial *g* to the figure 2, the product. Rack 1 moves one tooth, which turns the pinion on the round shaft one tooth, which turns the dial *f* to 1, the multiplier.

Example: 9×9. Left-hand pinion in mesh with rack 9. Pushers raised up to tenth ("9") notch. The movements of the racks are the same as in the example 1×9. As the pinion of the square shaft is this time in mesh with rack 9, which is pushed eight teeth in the first half revolution by the tens pushers, the left-hand *g* dial which is in line with this shaft is turned to show "8." During the remainder of the first half-revolution the carriage is stepped forward one place.

During the second half-revolution, as shown in the previous example, the No. 9 rack is pushed one tooth. As the second *g* dial is now in line with the square shaft driven from rack 9, the second *g* dial is caused to turn to show "1," thus causing the product 81 to show through the face of the machine. During the second half revolution also, the No. 1 rack moves nine teeth to the right, as in the example 1×9, so the *f* dial is caused to turn to 9, indicating the multiplier as before.

Example: 12×24. Carriage at the extreme right.

First cycle: Pinion on first (left-hand) square shaft in mesh with rack 1. Pinion on second square shaft in mesh with rack 2.

First we multiply by 2; pushers are raised up to "2" notch.

First half revolution, racks 5 to 9 inclusive are pushed one notch to the right, as in the example 1×2. As nothing is in mesh with them, no dials are turned. The carriage shifts.

Second half-revolution, the racks are shifted again as in example 1×2; as No. 2 moves two teeth before No. 1 starts to move, the third *g* dial is rotated to 2. At this point No. 1 starts moving also, and No. 1 and No. 2 simultaneously move two teeth. The first of these makes a third *g* dial move to "3," while the second *g* dial moves to "1." The next tooth makes the third *g* dial move to "4," and the second one to "2." Also the two-tooth motion of rack 1 causes the left-hand *f* dial to turn to "2." The return of the racks completes the first cycle.

Second cycle. The only change made is to raise the pushers up to "4" notch by movement of the multiplier lever *H*.

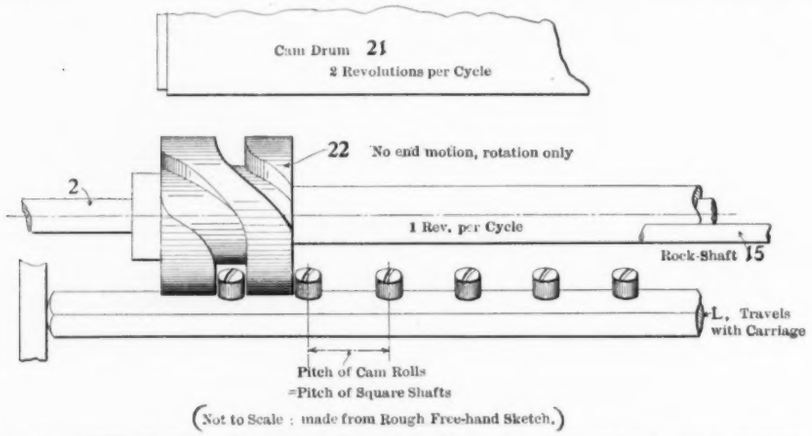

Cam Drum 21
2 Revolutions per Cycle
22 No end motion, rotation only
2
1 Rev. per Cycle
Rock-Shaft 15
L, Travels with Carriage
Pitch of Cam Rolls
=Pitch of Square Shafts
(Not to Scale : made from Rough Free-hand Sketch.)

FIG. 11. INVERTED PLAN NEAR LEFT END OF CARRIAGE, SHOWING HELICAL CAM WHICH GIVES THE CARRIAGE TRAVEL.

Example: 1×3.

MOVEMENT OF RACKS EXPRESSED IN NUMBER OF TEETH.

Rack Number.	First Push.	Equivalent.	Second Push.	Aggregate.
1	0	0	3	3
2	0	0	6	6
3	0	0	9	9
4	1	10	2	12
5	1	10	5	15
6	1	10	8	18
7	2	20	1	21
8	2	20	4	24
9	2	20	7	27

MOVEMENT OF RACKS FOR THE WHOLE CYCLE, MULTIPLIER = 4.

Rack Number.	First Push.	Equivalent.	Second Push.	Aggregate.
1	0	0	4	4
2	0	0	8	8
3	1	10	2	12
4	1	10	6	16
5	2	20	0	20
6	2	20	4	24
7	2	20	8	28
8	3	30	2	32
9	3	30	6	36

As the two racks with which the pinions are engaged are not moved during the first half-revolution, there is no effect on the dials. The carriage steps forward, bringing the fourth *g* dial in line with the second square shaft, that is, the one having its pinion in mesh with No. 2 rack

During the second half revolution No. 2 rack moves eight teeth, so the fourth *g*

dial is turned to "8." No. 1 rack moves four teeth, the shaft whose pinion is meshing with this rack is now in line with the third *g* dial, which was showing "4." The additional movement of four teeth which it now gets makes it read 4 + 4, or "8." The second *g* dial remains at "2." The product shown is therefore 288. The round shaft is in line with the second *f* dial, which turns to the same figure as the number of teeth moved by No. 1 rack, viz., "4," thus, when read in connection with the first *f* dial, causing the multiplier 24 to be shown through the face of the machine. The completion of the crank rotation returns the pushers and racks home.

Whenever the movement of a *g* dial, added to the amount which it had already turned, causes it to turn from 9 to 0, the

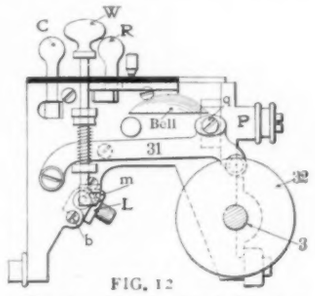


FIG. 12
Elevation of Left-hand End of Carriage

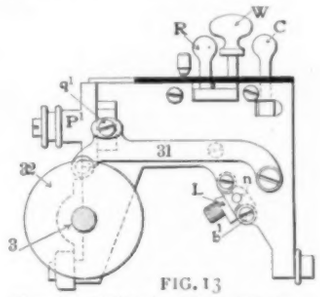


FIG. 13
Elevation of Right-hand End of Carriage

FIG. 14 Plan of Bar with Carriage-Feed Cam Rolls

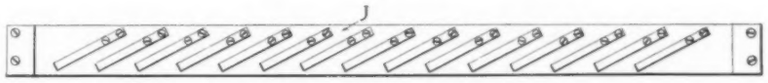


FIG. 15 Stop Springs for the Ten-carrying Rock-Shafts (Plan)

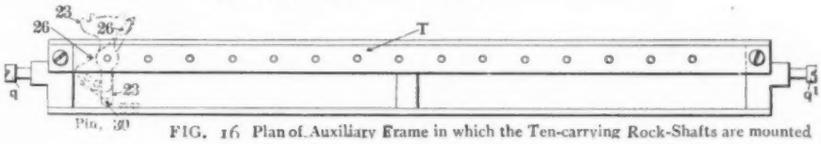


FIG. 16 Plan of Auxiliary Frame in which the Ten-carrying Rock-Shafts are mounted

DETAILS OF THE TRAVELING CARRIAGE

decimal-counting mechanism ("carriers of ten") is caused to act in a manner which will be described under that heading.

ACTION OF THE PUSHER BARS AND SUCCEEDING PARTS IN DIVISION

The regulator lever *U* on "*D*," the dividend on line *g g*, the first figure to the left to be on the second dial *g*, carriage to the extreme right, and divisor indicated by the markers *e*, starting at the left.

Example: $\frac{352}{22} = ?$

First cycle. We take for the trial quotient 1 by inspection, set the pushers at the "1" hole by the lever *H*, and turn the crank. During the first half-revolution, the only effect is to advance the carriage one step. During the second half revolution, the second and third *g* dials (figures 3 and 5 of the dividend) are turned backward two teeth by motion of rack 2, so that they now read 1 and 3 and the new dividend 132 shows on the *gg* line. At the same time the first *f* dial is turned to 1, the partial quotient.

Second cycle. By inspection, or by the use of the convenient table inside the cover of the machine, we see that the probable figure of the quotient is now 6. We set the pushers to the "6" hole notch, turn the crank, and the result of the two pushes of the racks is to turn the dials *gg* backward, subtract 6 times 22 from 132, leaving 0 as the remainder. It is thus seen that division is a combination of multiplication and subtraction. The second *f* dial is turned to 6, thus indicating 16 as the quotient.

It is evident that the lever *H* may be set at the No. 1 hole, and division performed by successive subtractions, as is the only way possible in some machines; however, the method described will usually be found more rapid.

THE CARRIAGE TRAVEL

During addition or subtraction the carriage does not travel.

During multiplication or division it travels one place to the left for each cycle of movements.

19, Figs. 4 and 10, is a clutch under the control of the lever *U*, through the arm 20, which is mounted on the same shaft as *U*. The clutch, like the lever, has four positions. When it is in either of the two extreme positions, the mechanism which causes the carriage traverse is disengaged. When it is in either of the two intermediate positions, the carriage is driven by the helical cam 22, Figs. 11 and 17. In Fig. 17 is shown the helical cam developed. Fig. 11 shows the position of the parts when the carriage is at the right-hand end of its travel and the crank *K* is at home. This view is a plan, looking up through the bottom of the machine, and it shows the bar *L* (detailed in Fig. 14) with its cam rolls, the spacing center to center of which is equal to the distances center to center of the square horizontal shafts 9, and as the carriage is fed to the left one pitch distance at each cycle, it is evident that the shafts then come in line with the *gg* dials one place to the right of the ones with which they were first in line. The shaft 2 makes one revolution per cycle, and the cam roll, which was in the central portion of the groove, remains at rest until the inclined portion of the groove reaches it, when it is caused to move to the left a distance equal to the distance between the centers of the cam rolls on the bar *L*. At the same time the next roll to the right enters the right-hand inclined groove, so that when the revolution of the shaft ceases, the first roll has emerged to the left of the cam, and the second now stands in the idle portion of the groove, the same as the first one did at the start. The carriage travel takes place during the latter part of the first half-revolution of the crank *K*, the carriage remaining stationary during the second half-revolution.

HAND TRAVEL OF THE CARRIAGE

This is effected by pushing down on the knob *W* and sliding the carriage to any desired position. The action is made plain by referring to Fig. 12. The knob *W* is screwed to the upper end of a square rod, having a spring to keep it pushed up, and a jaw on its lower end. This jaw takes hold of a little crank pin *m*, belonging to a crank (see Fig. 14) carried on the end of the bar *L*, upon which are mounted the rolls which mesh with the helical groove. When the knob *W* is pushed down, the bar *L* is rotated about 80 degrees, throwing the rolls out of engagement with the helical groove, and leaving the carriage free to be traversed by hand.

THE MECHANISM FOR CARRYING TENS

This consists of means by which at the proper time a dial *g* may produce rotation of one index figure in its neighboring dial. It does this by automatically setting the mechanism so that it may be acted upon by cams on the cylindrical surface of the drum 21 as they come around.

The mechanism can be seen in vertical section in Fig. 17; Fig. 20 is a plan of part of it with the corresponding cams represented in the same horizontal plane in order to illustrate their action on the pin in the swinging rocker arm. Figs. 12, 13, 15, 16 and 21 also show some details.

When a dial *g* changes from 9 to 0, the wing 25 on the spindle of the dial *g* swings the arm 26 over and this swings the arm 23 which is on the same shaft.

so that the teeth on 23 are nearly in mesh with the gear wheel 27 on the next *g* spindle. Then when the brass cam 28 comes around, it moves the pin 30 over a little farther and with it the rock shaft 24, and the segmental gear 23, causing the next dial *g* to rotate one tooth. When the restoring cam 29 comes along, the pin 30, the rock shaft, and its arms, are restored to normal position, but in the meantime the frame *T* carrying the rock shafts is raised up so that the segment 23 is not in mesh with the gear 27 during the backward motion.

The rising and falling of the auxiliary carriage *T*, Fig. 16, and the mechanism just described which it carries (consisting of the rock shafts, arms and segments, their pawls, click springs, stop pins, etc.), is effected twice per cycle by means of the trunnions *q* and *q'*, which are embraced by the ends of the levers 31, Figs. 12, 13 and 17, at the ends of the carriage, which have at their outer ends cam rolls engaging with the cams 32, Figs. 5, 8, 12, 13 and 18, which give them a radial motion. When this frame is raised up, the segments 23 are out of mesh with the gear wheels 27. The frame is raised up about the beginning of the revolution of the cam drum and stays up for a little over one-half revolution, and then drops down, staying down until near the end of the revolution, when it starts up again, being part way up when the crank *K* is at home. As the cam-drum shaft makes two revolutions per cycle, the frame, as stated above, rises and falls twice per cycle.

During subtraction and division the action, of course, works the other way from that in addition and multiplication, the change being from 0 to 9 instead of from 9 to 0; and the arms of the rock shafts are swung in the opposite direction, the cams 28 and the working surfaces of the restoring cams 29 being in pairs, and the segments 23 having teeth on both sides of the center lines, so as to make full provision for accomplishing this.

The cams 28 are not arranged in a straight line parallel to the axis of the cylinder, but are located along a helical line on its surface. This has two advantages: it reduces the amount of power required to operate the machine, as the rock shafts are swung one at a time, instead of all at once; and it permits of carrying a ten through an entire series of figures,

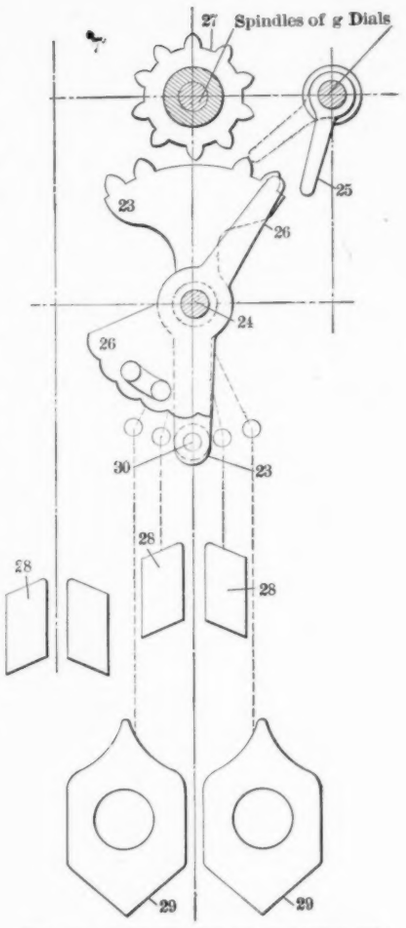


FIG. 20. PART OF THE MECHANISM FOR CARRYING TENS ON THE DIALS *gg*

one after another, as would be required, for instance, when the transferring mechanism adds 1 to a number 999,999 already on the result dials.

THE DRIVE OF THE DIALS *f f*

To the left of the square shafts is a round shaft 11, Fig. 4 (not shown in Figs. 6 and 9), having near its back end a pinion permanently meshing with rack 1. This pinion also meshes with a gear on the parallel shaft 33 above it, which carries on its forward end a gear 34 driving another gear 35 below it, mounted on the back end of the short square shaft in line with the round shaft 11 first mentioned. This last shaft has two miter gears mounted on it, similar in arrangement to the gears 12 and 13 on the square shafts 9 which drive *g g*; but in this case the miter gears are farther back, so as to be below a horizontal miter gear (36, Fig. 17) on the lower end of one of the *f* shafts, whichever one the position of the carriage causes to be in line. The motion of the rack 1 is thus communicated to the dial *f*, so that in addition or subtraction *f* is caused to turn one unit for each cycle, and in multiplication *f* turns as many units as are in the multiplier, or in division as many units as are in the partial quotient. In the latter case the carriage steps forward one place for each cycle or turn of the crank *K*, hence the same *f* dial is not turned twice

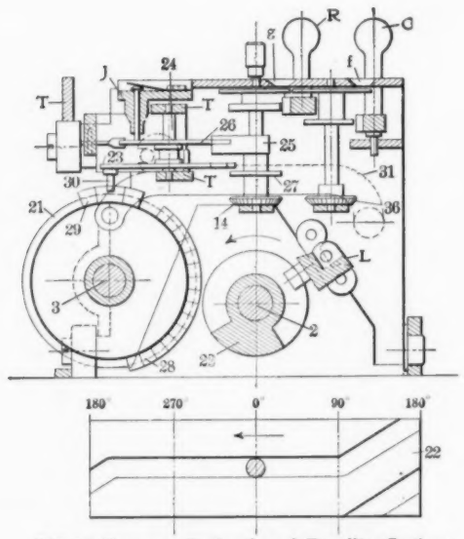


FIG. 17 Transverse Section through Travelling Carriage; and Development of Helical Cam

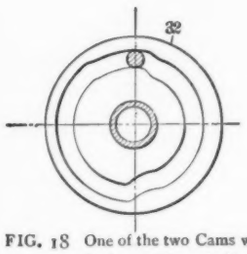


FIG. 18 One of the two Cams which move the frame T vertically

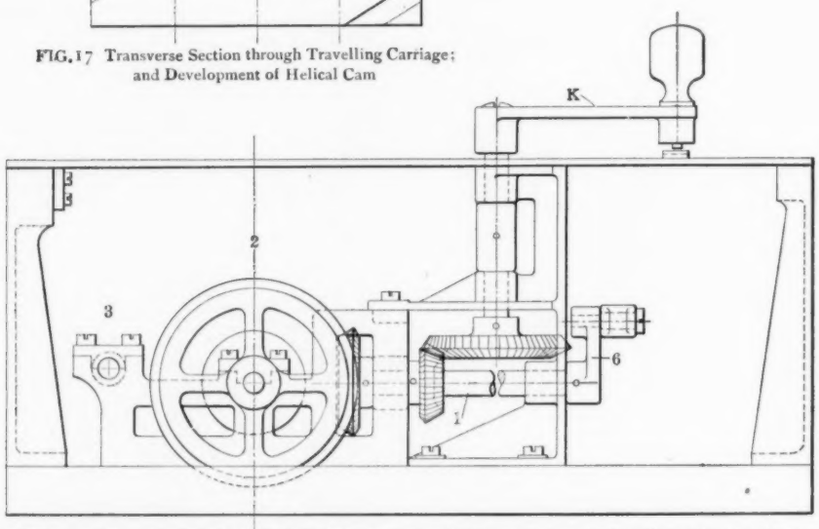


FIG. 19 Elevation of Right-hand End of Machine, Showing Transmission of Motion from Hand-crank K

in succession. This turning of the *f* dial is done during the second half-revolution of the crank *K*, as during the first half revolution the No. 1 rack is not moved. The dial *f* does not move backward when the rack is pushed back by the cross-head, because by that time the miter gear on the short square shaft has been moved out of engagement with the horizontal miter gear on the *f* shaft. The motion of these two miter gears back and forth on their short square shaft is exactly the same, synchronous with and produced by the same mechanism as the motion of the miter gears 12 and 13 on the square shafts 9, which actuates the dials *g g*, and which is described under the head "Action of the Rack Pinions, Square Shafts and their Bevel Gears," so that during addition or multiplication the dials *f f* are turned in one direction and during division or subtraction they are turned in the other direction. The dials *f f* are graduated from 0 to 9, and then back again; that is, every figure except 0 and 9 is duplicated on the dial, because of its motion in opposite directions during multiplication and division. The dials *g g* read merely from 0 to 9.

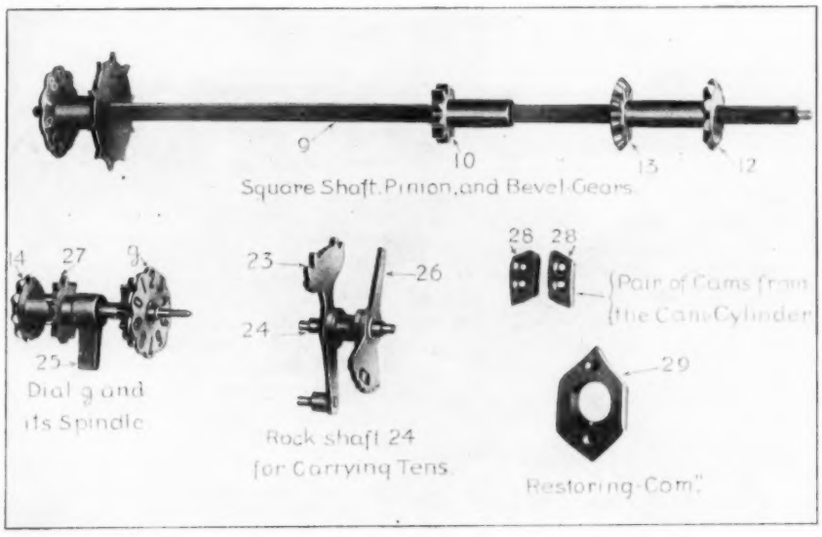


FIG. 21. A FEW OF THE PARTS OF THE CALCULATING MACHINE

TABLE OF EVENTS

The following parallel shows the relative succession of the different functions in the machine during one turn of the crank *K*:

0 degrees—Engagement of the bevel gears of the transferring mechanism with the register mechanism.

0 degrees to 90 degrees—Transfer of the ten values and commencement of the action of the registering mechanism.

Disengagement of the bevel gears from the register works.

90 degrees to 180 degrees—Return in idleness of the racks; shifting of the carriage and the register works to the left. Completion of the registering of the tens.

Engagement of the bevel gears with the register works. Shifting of the multiplication-table structure.

180 degrees to 270 degrees—Transfer of the unit values and commencement of the action of the registering mechanism.

Disengagement of the bevel gears from the register works.

270 degrees to 360 degrees—Return in idleness of the racks; combination of the units values with the tens values by the registering mechanism.

Shifting of the multiplication-table structure or pusher plates to the original position.

REFERENCE MARKS

To facilitate reference to the illustrations, the following table of the symbols employed throughout all the cuts is given here:

B Top plate, front.
C Effacing knob for dials *f*.
E Top plate, left back.
F Top plate, center back.
G Top plate, right back.
H Multiplication lever.
J Stop-spring supporting bar.
K Hand crank.
L Carriage-feed cam-roll bar.
R Effacing knob for dials *g*.
T Auxiliary frame.
U Regulator lever.
W Carriage-shifting knob.
Z Racks.
c Markers.
c' Marker dials.
f Indicating dials.
g Result dials.
m Crank on end of *L*.
n Trunnions for *L*.
q q' Trunnions for *T*.

1 First horizontal shaft (crank shaft)
2 Second horizontal shaft (helical-cam shaft)
3 Third horizontal shaft (cam-drum shaft)
4 Pusher-shifting cam on end of shaft 2
5 Cross-head.
6 Crank on shaft 1.
7 Connecting rod.
8 Bars connecting cross-head to pusher frame.
9 Square or pinion shafts.
10 Sliding pinions.
11 Indicator shaft.
12 Front miter gear on square shaft.
13 Back miter gear on square shaft.
14 Horizontal miter gear on shaft of *g* dial.
15 Horizontal rock shaft.
16 Rocker arm on 15.
17 Addition-multiplication cam.
18 Division-subtraction cam.
19 Clutch.
20 Clutch-shifting arm.
21 Cam cylinder or drum.
22 Helical cam for feeding carriage.

MECHANISM FOR CARRYING TENS

23 Rocker-arm and spur-gear segment.
24 Rock shaft.
25 Wing on *g* dial spindle.
26 Rocker-arm and rose-wheel segment.
27 Spur gear on *g* dial spindle.
28 Cam for carrying tens.
29 Restoring cam.
30 Pin in rocker arm 23.
31 Lever for lifting auxiliary carriage.
32 Cam for lifting auxiliary carriage.

33 Shaft driven from shaft 11.
34 Gear on front end of 33.
35 Gear driven by 34.
36 Gear on lower end of *f* spindle.

Recent tests have shown that the degree of wetness or dryness has very much influence upon the strength of a grindstone. Dry stones showed a tensile strength of from 146 to 186 pounds per square inch; after soaking all night they broke under stresses of from 80 to 116 pounds per square inch.

Following upon the announcement of the playing-out of the iron mines in Iron Mountain, Mo., comes the statement that the Mexican Government at last is going to permit the working of a remarkable mountain in Durango, Mexico, which is said to be almost solid iron, and is 2000 ft. high and about ¾ of a mile thick at the base. The ore, it is stated, yields about 78 per cent. of pure iron.

The new tunnel under Capitol Hill, Washington, between the Capitol and the Congressional Library, which the Pennsylvania Railroad Company has been building for southern connections, has been completed. It is 4033 feet long, and is composed of two single-track tubes, separated by a masonry wall. The new station into which all the trains entering the Capital City are to run, will be one of the largest and finest in the United States.

INDUSTRIAL DEVELOPMENT OF CANADA

Unlimited Water Power and Development of the Northwest Assure Future for Electrical and Agricultural Manufacturing—The Shortage of Labor and the Alien Labor Law—Peculiar Conditions of Branches of American Factories—The Scarcity of Timber and Its Effect on the Building Trades—Increase of Manufacturing Plants—Backwardness of the Lower Provinces.

EDITORIAL CORRESPONDENCE

Living as I did in Canada in the early nineties, and knowing the limited development of mechanical industries there at that time, a recent trip through Ontario, Quebec and Nova Scotia has given a highly appreciated opportunity for making comparisons which have been interesting to me, and which may prove so to others. Of course, the results of observations of this kind cannot be presented as a census, and, no doubt, developments have been passed by which are quite as deserving of notice as some of those which are noted.

HAMILTON, ONTARIO

The first point at which these observations began was at Hamilton, Ontario, where, during recent years, branches of the Westinghouse industries and of the International Harvester Company have been established. The Canadian Westinghouse Company began operations eight or nine years ago in an old building which was, and still is, used exculsively for air-brake work. To this a large addition has recently been made for the electrical branch of the company's industries, the present buildings being, however, but a small part of the entire contemplated plan. The buildings, like all of the recent manufacturing plants in Canada, are of thoroughly modern construction, steel frame and reinforced concrete, and they supply employment for about 1500 employees, of whom by far the larger number are engaged in electrical work. The future of this work in Canada is undoubtedly bright, as the country is remarkably well watered, and possesses water power in unlimited quantities.

In the same town are the Canadian works of the International Harvester Company which have just completed their third season, and which are really of imposing magnitude. They consist of three high, splendidly lighted, steel-frame monitor-roof buildings used for gray and malleable-iron foundries and forge shop respectively, and ranging between 800 and 1000 feet in length each. Connected with them is a great four-story machine shop and a three-story warehouse, making a combination which is decidedly impressive.

When these works were established, much was said about the supposed intention of the International Harvester Company to transfer its export work to them, but as a matter of fact, very little of this has been done, and there is very little prospect that it will be done to any considerable extent. So far the entire product of the works, which employ 2000 hands, has been consumed in the rapidly developing Canadian Northwest—a fact which speaks eloquently of that development. Meanwhile further and much needed enlargement of the operations of the plant is seriously interfered with by the shortage of labor, of which complaints were heard in practically every shop visited. This has become so serious that it formed the chief topic of discussion at the recent Winnipeg meeting of the Canadian Manufacturers' Association. In addition to this difficulty in connection with the doing of export work at these works, is the further fact that the company finds no advantage in the matter of cost in doing its work in Canada. It finds the labor cost to be no less than in the States, while materials are distinctly higher, and of course in machinery of the agricultural class, the cost of the material forms a very high proportion of the total cost.

In this town are also located the new works of the London Machine Tool Company which were recently removed from London, Ont. They occupy new and high-class buildings and employ seventy-five men. They devote themselves chiefly to heavy tools, some of their recent railroad tools having given remarkable results.

THE ALIEN LABOR LAW

In connection with the shortage of labor it should be mentioned that Canada has taken a leaf from our own contract labor law and passed similar legislation, known as the Alien Labor Law, by which the engagement of workmen outside the borders of Canada by Canadian employers is punished by a heavy fine. Meanwhile Canada is hungry for immigration, the Canadian Government using every legitimate means to encourage it, and it does seem a little odd that the man who is so forehanded or so lucky as to secure employment in advance should be the very man to be shut out.

BRANCHES OF AMERICAN FACTORIES

Most of those factories which are established in Canada as branches of American enterprises lean on the parent organization to a considerable extent during their early years. I saw some of this and can appreciate its necessity from my former connection with the Canadian Rand Drill Company. The output required for the Canadian market is practically as varied as that at home, while the product in any one line is materially smaller and in some cases so small as to make it inadvisable to attempt manufacture in Canada, it being more advantageous to import from the American factory and pay the duty than to fit up for manufacturing in small lots, or to attempt such manufacture in limited quantity without the equipment which large lots alone justify. These facts, added to the further fact that many kinds of material are not made in Canada, lead to heavy imports by Canadian factories from their parent shops as well as from makers of raw material.

The above explains in a few words the conditions which ordinarily attend the organization of a Canadian branch factory by an American house. As time goes on dependence on the home factory becomes less and less until in some cases—notably those of the Canadian Rand Drill Company and the Canadian General Electric Company—independence becomes ultimately practically complete, even to the point of originating designs which, in some cases, I am bound to say are good enough to be worth copying south of the border. These remarks, as regards dependence on the home works, do not apply to the work of the International Harvester Company, whose works are unusually complete.

The city of Hamilton seems to have an assured industrial future due to its connection with the Niagara Falls power plant and to its being in the center of a district which supplies an unlimited amount of land for factory sites. While the rates vary according to circumstances, a fair figure for this power in Hamilton seems to be about three-quarters of a cent per horse-power hour and, moreover, there does not seem to have been any compensating advance in the price of real estate. The fact is there is too much of it to have its value in any large degree affected by the small quantity required for manufacturing purposes.

THE FUTURE OF NIAGARA FALLS

The importance of cheap power to the cities of southern Ontario bodes ill for Niagara falls. The tariff on American coal on the one hand and the distance from the coal fields of the Maritime Provinces on the other make coal expensive in this portion of Canada, which is and aims to be still more the manufacturing center of the Dominion and consequently, so far as I could learn, the prevailing sentiment seems to be overwhelmingly in favor of the development of the falls for power purposes to the limit. The strength of the movement for this development in Ontario has, indeed, called into existence there an active opposition

party, but this opposition is relatively feeble and seems powerless to accomplish its purpose in the face of material interests.

Elsewhere in the Dominion there is so little interest taken in the subject that it cannot be said to be a public question at all. The public at large is apathetic and the subject is scarcely discussed in the newspapers. Of the attitude of the Dominion Government it is impossible to speak with assurance, but the general fact lies that that Government is very much alive to the promotion of manufacturing interests in Canada in which policy it is paternalistic to an extent unknown to us. The subject of the hour is the industrial development of Canada, to which everything else is subordinated and before which such a sentimental subject as the preservation of an object of natural beauty would seem to have but little chance. I found so little feeling in favor of the preservation of the falls and in fact so little evidence that the subject is looked upon as one of any importance that I am bound to say the future of the falls appears to me to be decidedly gloomy.

A word of protest against the obvious trend of events brings out the ready retort "You Americans began it," to which of course no reply is possible. At the same time, looking into the future, should the statement of the situation be that while the Americans began the spoliation the Canadians finished it, such a statement, it seems to me, would not express an equality of blame. Community of action between the two governments is of course essential if the Falls are to be saved. Without that action the situation is bound to develop into a simple race in which the hindmost will share the usual fate of those who occupy that position. The situation as it stands seems to be, that while the American people are beginning to learn that there is something of importance in the world beside factories, the Canadians are not and there is very little prospect that they will learn it until long after Niagara Falls are destroyed forever.

In addition to the great plant of the International Harvester Company, there is the old Canadian house, the Massey-Harris Company, of Toronto, which has been supplying the Canadian demand for agricultural implements and machinery since 1847. This company has great factories in Toronto, Brantford and Woodstock, which employ collectively about 3000 men, which number represents a large increase in recent years. This company ships its products to all parts of the civilized world, and its factories are constantly undergoing enlargement.

In addition to the output of these two companies, about three millions of dollars worth of agricultural machinery and implements are imported annually into Canada. The reason for these importations lies in the great development of the Canadian Northwest with which the Canadian factories, great as they are, are not able to keep pace.

DUNDAS, ONTARIO

A half hour's ride by trolley from Hamilton, is the town of Dundas, where is located the machine-tool works of the John Bertram & Sons Company, now a branch of the Niles-Bement-Pond Company. The founder of these works, John Bertram, was a native of Scotland, as are so many of the leading citizens of Canada. He emigrated to Canada in his early days, and founded the existing works in 1861. They were the first to build machine tools of any description in Canada, their first product naturally being lathes. Mr. Bertram lived to see his works grow to be one of the best known industrial establishments in Canada, his widely and genuinely lamented death having taken place only last spring. It is related of him that on the occasion of a visit to his old home in Scotland shortly before he died, he went to see a water wheel built largely by his own hands forty years before, and still running without a shilling to its debit for repairs.

A visit to the works, which I had not seen since the early nineties, found them in the toils of almost complete rebuilding and enlargement. The old buildings, after the manner of their time, were poorly lighted, and they are being so altered and incorporated with new steel frame additions as to make them thoroughly modern. Of the additions, the foundry is complete, and is equal in its convenience and appointments to anything I have seen. At the present time, about 355 men are employed, the additions being intended to increase this number to about 500. To an unusual extent, these works have patronized themselves; their line of product has been very varied, and their equipment is composed to a very unusual degree of tools made by themselves. Their present policy is to curtail this line of product, although the conditions of Canada do not yet permit any large degree of specialization in machine-tool making. Across the street from the Bertram works is the shop of the Canadian Pratt & Whitney Company, where a small-tool branch of the business has been opened.

TORONTO

At Toronto the largest of the new works is that of the Canada Foundry Company, which is the largest general engineering works in Canada. Their product is very varied, ranging from bridges to locomotives, with a pipe foundry between. The works employ about 1400 men, and of structural iron work alone they turn out 700 tons a month. The bridge shop is especially complete, being 200x300 feet in size, with the walls composed so largely of glass as to make one wonder how it can be warmed in the winter. The machine shop is 300 feet in length, and is being doubled in capacity. Like all the other places visited, the floor was piled high with work.

These works were originally started in 1892 to be what their name indicates, a foundry, the intention being more especially to supply the Canadian General Electric Company of Peterboro with castings. Their present policy of undertaking such diverse classes of work as those mentioned above—and they make other things which seem to form a still more incongruous combination—would not, of course, be looked upon as sound in the United States, but the conditions of the two countries are radically diverse, and the various extensions that have been made have been the outgrowth of a strictly legitimate demand.

PETERBORO, ONTARIO

A town which is becoming one of the leading manufacturing centers of Canada, is Peterboro, Ontario, where the Canadian General Electric Company was established in 1890, after a short stay in Sherbrooke, Quebec. These works have now grown to large proportions, and employ in Peterboro alone 1100 men. The output comprises all classes of electrical machinery. They make the largest use of the premium plan of any works with which I am acquainted. The entire machine-shop force, excepting only the erectors and tool makers, work on that plan together with many other departments, such as winding, insulating, etc. The works have never had a suspicion of labor difficulties, and the general superintendent attributes the fact very largely to the satisfaction of the workmen with the workings of the premium plan. The works have doubled in the past five years, and large additions are now in progress, while others will be carried forward another season. The statement that these works have been so largely increased in capacity during the past five years might be substantially repeated as regards the length of time in connection with most of the other large enterprises, as pretty much everything of a mechanical nature in Canada seems to have happened within the past five years, the present era dating from about 1900.

Another considerable establishment in Peterboro is that of the William Hamilton Manufacturing Company, who are builders of all kinds of mill machinery, water-wheel work, and, to some extent, of mining machinery. They employ about 250 men, and, like other places, have had substantial growth in recent years.

SHORTAGE OF TIMBER

One of the most surprising things about the Canadian industrial situation lies in the timber situation. The average American considers Canada, except for its lower border, as one vast expanse of virgin forest. Nothing could be farther from the truth, the fact being that Canada is face to face, much to her own surprise, I fancy

with a shortage of timber. This is especially true with regard to hard woods, oak, ash and elm, the supply of which comes almost entirely from the States, from whence a large amount of Southern yellow pine and a good deal of white pine is also imported. It must be remembered that much of Canada is today unexplored. Until recently the great source of timber supply was the upper Ottawa valley, which made Ottawa the greatest lumber market in the world. The Canadians themselves seem to have thought this supply was practically unlimited. Of course, much sawing is still done, but this is largely of the trees that were passed by, originally, as not worth cutting.

The great Canadian Northwest is largely of the character of our own prairies, and contains but little timber. In eastern Canada there is found to be a marked change on passing the divide into the Arctic slope, beyond which the timber growth is limited in both quality and quantity, such as there is being chiefly spruce. The same is true of British Columbia which, while well timbered in the southern portions, is not so well favored in the northern.

There is one great supply still remaining in the Nipissing pine belt, which is a Government forest reserve where lumbering is not yet permitted. If open to free cutting this reserve would supply timber for many years to come; but the Canadian Government has become wise, and the days of wholesale destruction of the forests are over. Of course these reserves will be drawn upon eventually, but the rights to cut timber will go to the highest bidder, which alone assures that the days of cheap lumber in Canada are over for good.

The effects of the shortage of lumber are already apparent, especially in Ontario, in the character of the building operations, in which lumber is employed to a much smaller extent than formerly—small residences in the outskirts of the towns which one would expect to find of frame, as a matter of course, being now built of brick, and this to a very much larger extent than in American towns of the same size. For factory construction, the use of timber has practically ceased, the modern factories being built of steel, brick, and reinforced concrete, the last named material being used to a larger extent, relatively, than with us.

MONTREAL

One of the largest recent enterprises in Montreal is that of the Locomotive and Machine Company of Montreal, which is a branch of the American Locomotive Company. The locomotive works are located in brand new shops, of the most modern construction and equipment. They give employment to about 1250 men, and turn out three locomotives per week. The works are very much congested, and an addition to the machine shop is now in progress, which will increase the capacity to about 4½ locomotives per week.

These works also supply an illustration of the incongruous combinations which are so often seen in Canadian works, as they comprise a bridge works in addition to the locomotive works.

At Lachine, a suburb of Montreal, are the entirely new works of the Allis-Chalmers-Bullock Company—a name which at once suggests the American affiliations of this company, which made its entry into Canada by acquiring the interests of the James Cooper Company of Montreal, the former business of the old company in Ingersoll rock drills and air compressors and Lidgerwood hoisting engines being continued, although the principal products are electrical machinery and hydraulic work in connection therewith. The works employ about 600 men, a number which is likely to be increased to a thousand next year by reason of extensions which are already begun.

Near the Allis-Chalmers works are the works of the Dominion Bridge Company, whose output from 1900 to the present year has increased from 16,000 to 36,000 tons of structural work per annum. Going back to 1890, the annual output of these works was but 4000 tons. In this connection it may be remarked that the aggregate output of all the structural work in the Dominion increased from about 8800 tons in 1890 to 60,000 tons in 1905. This class of work received a great impetus in the late nineties, when the railroads began the reconstruction of their old briages in order to carry heavier rolling stock. This work is still in progress, but its end is in sight, with no apparent demand to take its place unless the construction of steel-frame buildings shall largely increase.

At St. Johns, Quebec, the Singer Sewing Machine Company is establishing and has already in partial operation a factory with a capacity of a thousand machines per week.

SHERBROOKE, QUEBEC

At Sherbrooke, Quebec, where I formerly lived, and with which town I am naturally most familiar, the improvements are numerous and gratifying. The town has increased in population from ten thousand to fifteen thousand with a corresponding enlargement of its boundaries and the building of many tasteful and modern dwellings, although the increased use of brick already noted with respect to Ontario is not here so obvious. A new street-railroad system, a new court house, a new theater, new hotels and numerous new business blocks and other improvements of a miscellaneous character were noted—all of a kind which people do not make unless they are prosperous. In this connection, it may be said that perhaps the most striking change of all is in the temper of the people. One sees no more of the sensitiveness which formerly characterized the Canadian people over the backwardness of the development of Canada as compared with that below the border, but on the contrary a healthy feeling of assured confidence that Canada's day has at last come and that the present is the beginning of an era of large development.

The works of the Canadian Rand Drill Company, with which I was concerned in their early days, have grown until the machine shop of the modern monitor-roof construction covers 300x100 feet. It is crowded with work, twelve compressors of sizes above 14 inches in diameter, three of them for pressures of 1000 pounds, being in progress at the time of my visit. In its machine, pattern and blacksmith shops over 200 men are employed, while a new foundry is in process of erection and an enlargement of the machine shop is in contemplation. As an illustration of the changed situation in the timber market, it may be remarked that when the machine shop of this company was built seven years ago, nothing but a timber frame was considered, while for the foundry now in progress of construction nothing but a steel frame was considered.

This shop was the scene of the original trial of the premium plan, where it was installed experimentally in 1891. It long ago became incorporated in the administration of the shop, where it is taken quite as a matter of course.

In the same town are located the works of the Jenckes Machine Company, under whose sheltering wing the Rand business was originally established. These works have grown until they employ some four hundred men, which is about twice the number employed five years ago. Meanwhile the same company has established a branch works for boiler and similar construction, in St. Catherines, Quebec, where about a hundred additional men are employed.

The products of this company comprise mining machinery of all kinds, steam engines, pulp mills, water wheels and hydraulic work generally, together with mill gearing and much else that is scarcely capable of classification. Their products are found and their name plate is known from the Atlantic to the Pacific oceans. Much of the heaviest hydraulic work of the Canadian Niagara Falls power plant is theirs.

AMHERST, NOVA SCOTIA

At about the time I went to Sherbrooke to establish the air-compressor and rock-drill business, E. J. Armstrong, now of the Ball Engine Company, went to Amherst, N. S., to establish the building of high-speed engines. The outcome has been the business of the Robb Engineering Company of Amherst, who occupy a new shop built in 1904 and employ about four hundred men on work of the highest grade. Their present products comprise high-speed single valve, short-stroke medium speed, and long-stroke moderate speed Corliss valve engines. In the same town are the works of Rhodes, Curry &

Co., which are an entirely new development since my day. They are building contractors, freight- and street-car builders, and employ about a thousand men.

CAPE BRETON

At the far end of Canada, in Cape Breton, there has been a great development in coal and iron mining and in iron and steel making. The Dominion Coal Company was organized about 15 years ago and it operates today one of the greatest colliery propositions in the world, its employees numbering ten thousand men, while in the same vicinity the Dominion Iron and Steel Company employ 2500 men and other large enterprises are located in the same section. Sydney, which in the early nineties was a sleepy town of two thousand people, has grown to ten thounand, while Glace Bay has grown in the same time from about two thousand to fifteen thousand.

THE LOWER PROVINCES

Except for a few striking cases of this kind, there is, however, less evidence of general progress in the "Lower Provinces" —New Brunswick and Nova Scotia—than in other parts of Canada. Of course there are some signs of progress, new buildings and especially greatly improved pavements in Halifax, but the general aspect of that town can scarcely be said to differ from what it was when I first knew it 15 years ago. The train service of the railroads has scarcely increased and there is the same chronic lateness of trains. The character of the railroad service is, however, in the estimation of the people, largely due to the fact that the Intercolonial Railway, connecting Montreal, Quebec, St. John, Halifax and Sydney, is a Government-owned road. With their experience with this road as a guide, the Canadian people are a unit in opposing further extension of the government-ownership idea.

The limited development of these provinces is, no doubt, largely the outgrowth of the isolation of this part of Canada, due to that remarkable wedge which forms the northern part of Maine, and which almost cuts Canada in two, an arrangement which gives us a piece of territory of very little use to us while it does infinite harm to Canada.

The commercial conditions here are, however, unquestionably sound. At the combined Halifax agency of the Jenckes Machine Company and the Canadian Rand Drill Company, I was told the result of seven years' business as regards uncollected accounts and the total was so small as to seem almost absurd.

F. A. H.

Aluminum silver is now quite extensively used for the parts of typewriters most exposed to corrosion. The properties of the alloy are extreme stiffness together with a white color and sound casting qualities. It has replaced steel forgings or malleable iron castings which were formerly used for the purpose.—*Engineering and Mining Journal.*

Echoes from the Oil Country—Some Interesting Experiences in Interpreting Noises

BY W. OSBORNE.

The little company assembled on the porch this hot summer evening were discussing noises. They could hear, all too plainly, the chug, chug, chug—a hesitation as if undecided whether to continue or not, and then chug, chug, chug again.

"I think it is an outrage. They should not be allowed to put an engine in the residence part of the city unless it is fixed so that it can't make any noise. If it only kept steadily at it it would not be so bad; but that stopping and starting again so unevenly keeps a person's nerves all on edge."

"It isn't quite as bad as some of them," said one of the company, who was disposed to take a cheerful view of life, "for most of them let out a big crack every once in a while that sounds as if it had blown things all to pieces. This one hasn't done it yet."

One of the number worked in a gas-engine factory, and not wishing to be unpopular, he had been keeping discreetly quiet, as he thought. One of the ladies noticed it.

"That must be one of the engines you make over there where you work," she declared.

"No! I don't think it is one of ours; but listen a minute, and perhaps we can tell what make it is."

They all listened, and several guesses were made as to the type and maker of the engine. One of the ladies began to laugh, as she exclaimed: "It is easy to see what kind of men you fellows are around home. That noise is made by someone beating a carpet."

"Go away, you are dreaming," said a man who is very positive in his knowledge of a great many things. "That noise is made by a gas engine that has a hit-and miss governor."

"I don't know much about the noise any kind of a gas engine makes, but I know something about beating a carpet. That noise is made by a man who isn't afraid to beat a carpet for his wife, and he is doing a good job of it."

"It can't be very far away if that is it," said the peacemaker. "Let us walk down a ways and find out what it is."

They found a man beating a carpet.

This matter of engine exhaust in a city or village is often an important one; but it may be carried too far on some classes of engines. Most of us would rather be able to hear the chug that warns of the coming of an automobile than to be startled by the honk of the horn just in time to have it flash by before we have had time to decide which way to dodge. Perhaps, in time, we shall have a standard horn or a standard exhaust that will enable us to judge of the distance and speed of our adversary. At present, one is sometimes uncertain.

"Just wait a minute before crossing. There comes one of those pesky 'autos,' and from the sound of it, it is coming at a terrific rate."

"I should say it was coming," said his companion, as they paused on the corner. The noise was coming from a side street. "A man who runs like that after dark is likely to come sailing around the corner without thinking of anyone being in the way."

They waited long enough to let almost any kind of a moving vehicle get by without anything passing.

"If the exhaust wasn't getting louder and louder, I would think that they had the gear out." Just then there rolled into the range of the electric light on the corner, two small boys riding on a small wagon. The brick pavement had spaced the noise.

Perhaps most of us do not give sufficient attention to educating the ear in our ordinary affairs, although next to seeing, it tells us more than we learn in any other way. The things themselves leave impressions by the noises they make, when we are not always conscious of it. A man at work in a machine shop found himself thinking about the Ferris wheel. He had seen it at the St. Louis fair, and had sat near it for some time while he watched the crowds.

There was no particular reason why he he should think of it at this time, but again and again it came into his mind that he was seated on a bench near the wheel and watching the crowd. This act of his mind puzzled him, until he noticed that, among the other noises of the machine shop, was one very much like the one made by the dropping of the huge links of the sprocket chain that drove the wheel. Investigation showed that the noise was caused by a boy who was cleaning brass. He was running a large magnet through the brass, and then striking it on the edge of the box to dislodge any iron or steel chips which it had picked up. The stopping of the wheel to let off and take on passengers was closely reproduced when the boy took out the cleaned brass and put in another batch.

Almost every man in charge of moving machinery can tell stories of having the impression that something was wrong, and yet not being able to tell why he had it. Perhaps a consciously educated ear might have differentiated so accurately among the noises as to have at once located the trouble, the noise of which caused the uneasiness.

January, 1906, Mexico had approximately 10,500 miles of railroad in operation. The country is now entering another era of railway construction, and it is believed wihin the next few years large additions to the railway mileage will be made.—*Railroad Men.*

A NEW PERFORATING MACHINE

Instantly Adjustable to Any Length of Sheet — Spacing Between Lines of Perforation Easily Varied

In the preparation of sheets of paper which are to be used in the manufacture of check books, copy and note books of certain kinds and for a multitude of other purposes, a series of "tear off" perforations which in some cases extend straight across the sheet and in others but part way across, are necessary. These perforations are quite commonly spaced from 15 to 18 to the inch, and with punches formed of No. 65 Stubs' wire, about 1/32 inch material is left between the holes.

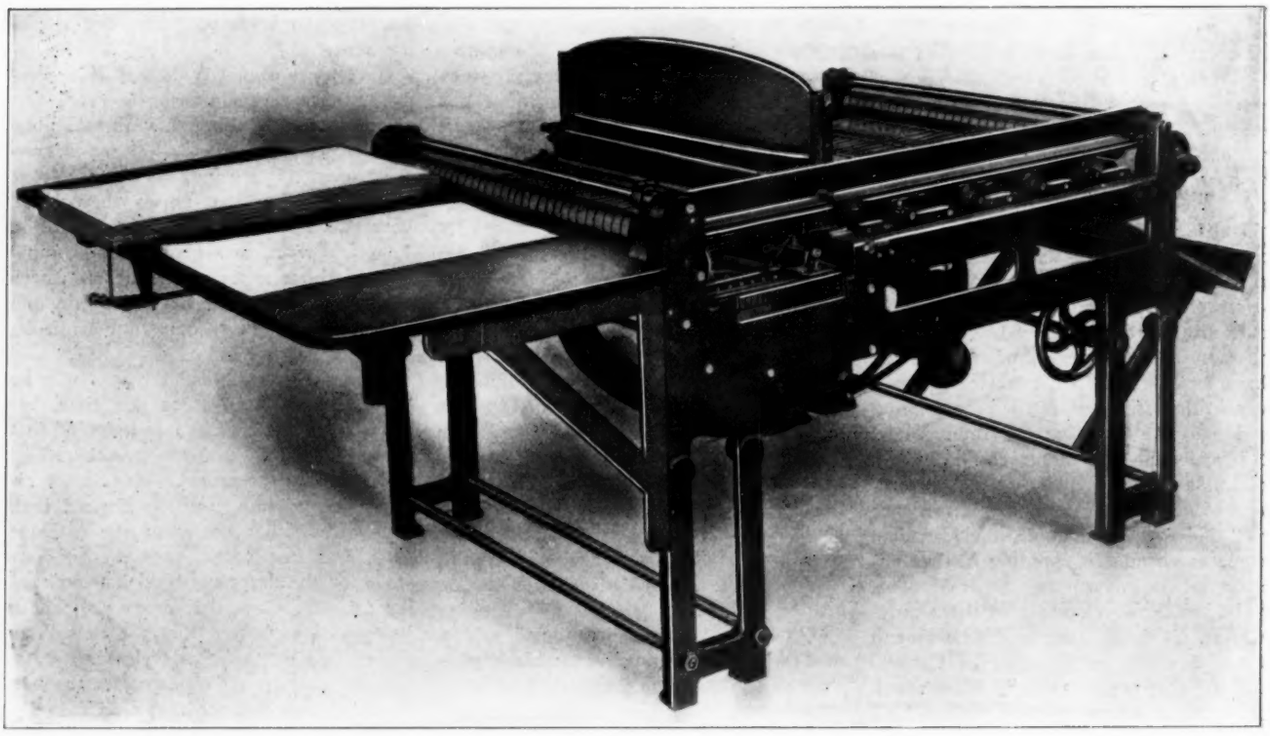


FIG. 1. GENERAL VIEW OF PAPER PERFORATING MACHINE

A newly designed machine for this work, the invention of Frederick Hart, of Poughkeepsie, N. Y., was seen in operation recently by an AMERICAN MACHINIST man, at the factory of the proprietors, Chas. S. Jonas & Bros., Beekman street, New York City. This machine embodies some very ingenious mechanism for controlling the movements of the punches and of the material to be perforated, and though designed primarily for operating on paper it should nevertheless prove of considerable interest to those having to do with the construction and operation of metal-working apparatus.

General views of this perforator are presented in Figs. 1 and 2, the latter showing the machine proper with the tables at the ends detached. Assembly drawings and details are reproduced in the line engravings Figs. 3 to 5. The machine is known as a 30x30 inch; that is, it will handle sheets of any size up to these dimensions, and at each stroke perforate a row of holes 30 inches long or the full width of the paper. The sheet may have one, two, three, four or more rows of holes punched through according to requirements; these lines of perforations may be close together or (within the limits stated) as far apart as desirable; and each series of holes may extend clear across the sheet or be interrupted by one or more blank spaces of any desired breadth. The change from one job to another is easily made as only the simplest adjustments are necessary in allowing for the length of the sheet and for the distance between successive rows of perforations. The half-tones represent the machine as set up for punching four rows of holes at about equal distances apart along the sheet.

In devising this machine Mr. Hart kept in mind the fact that much of the work which was to be handled thereon would be put through in small lots involving frequent changing over of the mechanism, and he, therefore, considered it inadvisable to employ in the construction regular cams, change-gears, etc., which to place in position and time accurately would mean a considerable delay each time the machine was set up for a different job. He, therefore, hit upon a scheme of control for instantly adapting the mechanism to suit any length of sheet, the controlling device while taking the place and performing the work of a series of cams being in no respect like a cam as that piece of mechanism is ordinarily understood; although the originator compares it to an expanding cam whose throw can be varied at will and which is automatically "pied" upon the completion of each cycle of operations and automatically built up again for the succeeding cycle. The arrangement of this ingenious device will be explained a little further on in this article.

THE FEED FOR THE PAPER

The paper (several sheets at once) is carried into the machine by two sets of feed strings at the front of the upright slide which holds the punches; two similar sets of tapes and strings receive the paper as it passes under the punches and remove it when perforated. By referring to the assembly drawing, Fig. 3, the front feed tapes will be seen at *A*, the rear tapes at *B*, the vertical slide for the punches at *C*. The rolls for the forward tapes are operated by a train of gears driven from a pinion *D* formed on a sleeve which carries at its opposite end a pulley *E* which is belted from the driving shaft under the rear end of the machine. The feed rolls at the rear are driven by bevel gears and a longitudinal

shaft from the feed train at the front. As long as clutch *F*, which is controlled by a hand lever, is in operative position, the feeding mechanism is running continuously to carry the work through the machine.

While the driving pulley *E* and the pinion *D* are running constantly, shaft *G*, which is formed with eccentrics at its ends for actuating the punch slide *C*, rotates only upon engagement of the clutch members *H*. This clutch is so controlled that at the right period in the cycle of operations it is automatically thrown into engagement and held there while shaft *G* is turned through one revolution to bring down and return the punches to their uppermost or normal position; upon the completion of which operation the clutch is opened and the shaft released until the paper has advanced the right distance to receive its next row of perforations.

THE GAGES OR STOPS FOR THE SHEET

Before the paper passes under the punches for the first line of perforations it is carried against a stop or gage *I* which lifts at the right moment relatively to the action of the rest of the mechanism and allows the work to pass along to gage *J*, which holds it while the punches descend. Upon the return stroke of the punch slide, gage *J* lifts and the work passes along to gage *K*, when the perforating operation is repeated; then the material passes to gage *L* and then to *M* and upon being released by the latter glides out of the machine with four rows of perforations, or as many rows as there are rear gages.

It is obvious that the desired distance between the rows is easily obtained by adjustment of the rear stops or gages. As will be seen from Fig. 2, these extend across the machine. They are of tubular form with depending wings which are brought into working position and returned again by oscillation of the gage through about one-quarter turn. Through each tube passes a small shaft with a pinion secured at either end, these pinions meshing with racks, as shown. A nurled handle forms a means of turning the pinion shaft in its bearings, thus giving the gage a parallel motion along the bed, a clamp bolt through the sliding blocks or boxes between which the gage is mounted being set up to maintain the position of the gage when correctly adjusted. The settings are readily made, either by measuring from a gage pin fixed in the side of the machine to the vertical edge of the sliding boxes, or by holding a sample sheet to the gage pin and setting the edges of these boxes to the perforated lines.

There are cases where the end of the sheet to be perforated is not square with the ruled lines thereon and in running through such material each gage may be set obliquely to the row of punches by simply turning a nut which disconnects the pinion at the far end of the gage. Fig. 4 illustrates the gage in plan and section and shows the different features just referred to.

GAGE AND PUNCH-SLIDE CONTROL

Having now stated briefly the functions of the gages and the method of adjustment, it will be next in order to consider the controlling apparatus previously alluded to, for timing the movements of these gages and the operations of the punch slide. In Fig. 2, at the extreme left of the machine and just back of the graduated plate, will be noticed a few links of a chain which in Fig. 3 may also be discerned at intervals along the frame, as at *N*. As there indicated, it passes over sprockets at the ends of the machine and details of both sprockets and chain will be seen in Fig. 5. In this engraving and in Fig. 3, *O* is the front sprocket and *P* the one at the rear, the latter sprocket having a friction device to prevent backward rotation. The shaft *Q* carries the lower roller *R* of the pair which drive the front-feed tapes, which roller, as already stated, runs continuously; and the outer end of the shaft passes freely through a bevel gear upon whose hub is secured a spur gear *S* which is connected by a train of gears with pinion *T* on shaft *G*, Fig. 3. The bevel gear *U* and a similar gear *V* at the end of the feed roll are connected by a pair of bevels, forming as shown in Fig. 5 a "jack-in-the-box" mechanism for the operation of sprocket wheel *O*. Now, when the clutch *H* on the shaft under the machine is thrown into action to give one complete stroke of the punch slide, the bevel gears *U* and *V* are driven in opposite directions at the same rate of speed

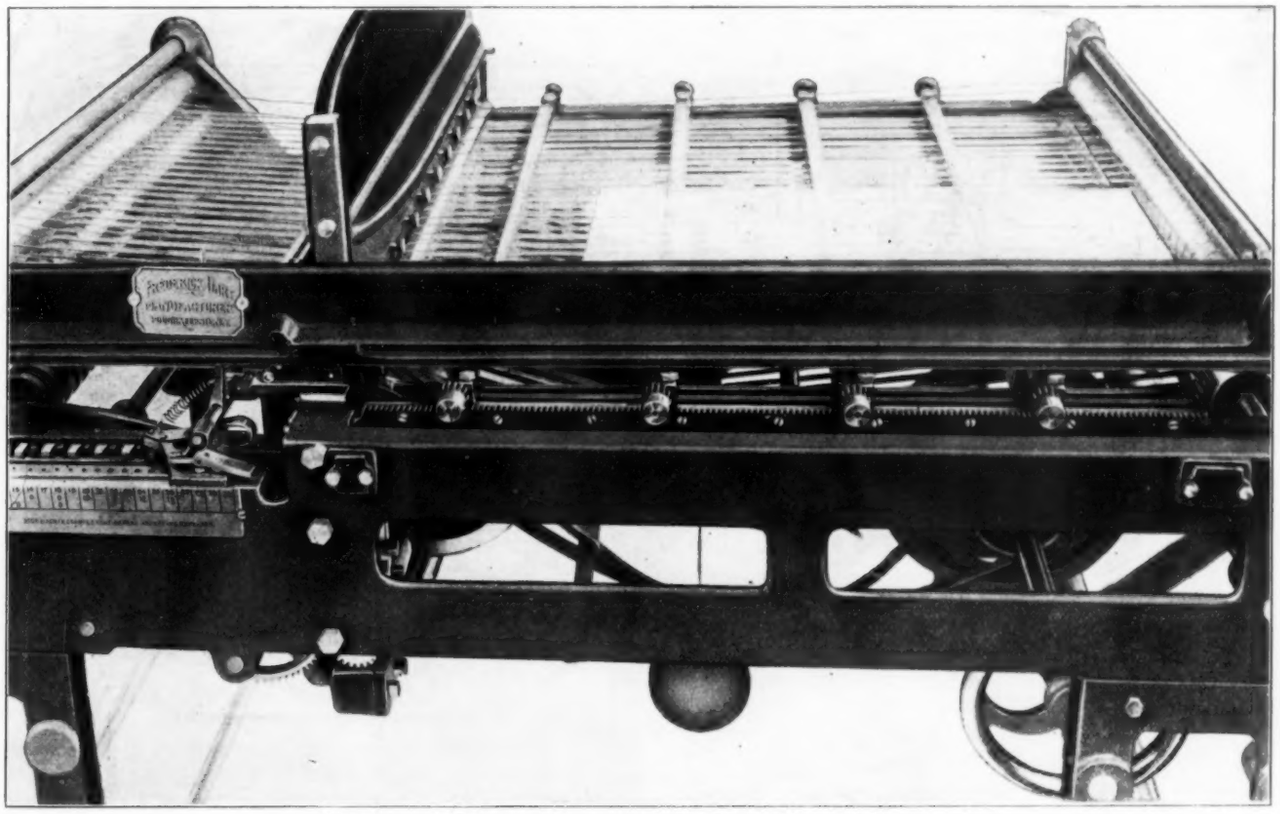


FIG. 2. SHOWING PERFORATING MACHINE MECHANISM

without imparting motion in either direction to the sprocket *O*. Upon the throwing out of the connecting clutch *H* on the shaft and the consequent stopping of bevel *U*, the sprocket and chain are, of course, driven in the same direction as roll *R*. The motion of the chain is thus an intermittent one and takes place only when the shaft *G* and the punch slide which it actuates are at rest.

This chain is made up of a series of 1-inch steel blocks, each carrying a pivoted dog *a*, which as required may be swung down as in the detail Fig. 4, to engage with a pair of small rocker arms *b* and *c* mounted at the end of each of the rear gages for the paper. The dog is also adapted to contact with a lever *d*, Fig. 3, and lift the front gage *I*, which drops back to normal position by gravity. Consider, now, one of the operating dogs in the chain immediately in front of the lever *d* to be swung into working position and the machine started: The dog first engages lever *d*, swinging up the front stop to permit the material to pass under the punches and then contacts with rocker arms *c* and *b*, Fig. 4, on the first rear gage. Arm *c* swings the gage down against a positive stop just before the paper reaches that gage; and *b*, acting through a simple connecting medium, causes the main clutch *H* on shaft *G* to be thrown into action, which immediately brings the chain to rest because of the balancing action of the bevel-gear arrangement already explained. The punches now descend and upon the return of the punch slide after the perforation of the paper the operating shaft *G*, having made one complete rotation, is automatically released by its clutch mechanism and the chain then proceeds forward until the dog contacts with and sets the second rear gage, bringing the paper to rest again and causing the main clutch to be thrown in once more and the punch slide to make another stroke. This process of course repeats itself as each gage is reached in order by the trip dog in the chain. When this dog reaches the rear sprocket it is snapped down into inoperative position in its link and so far as that particular dog is concerned the

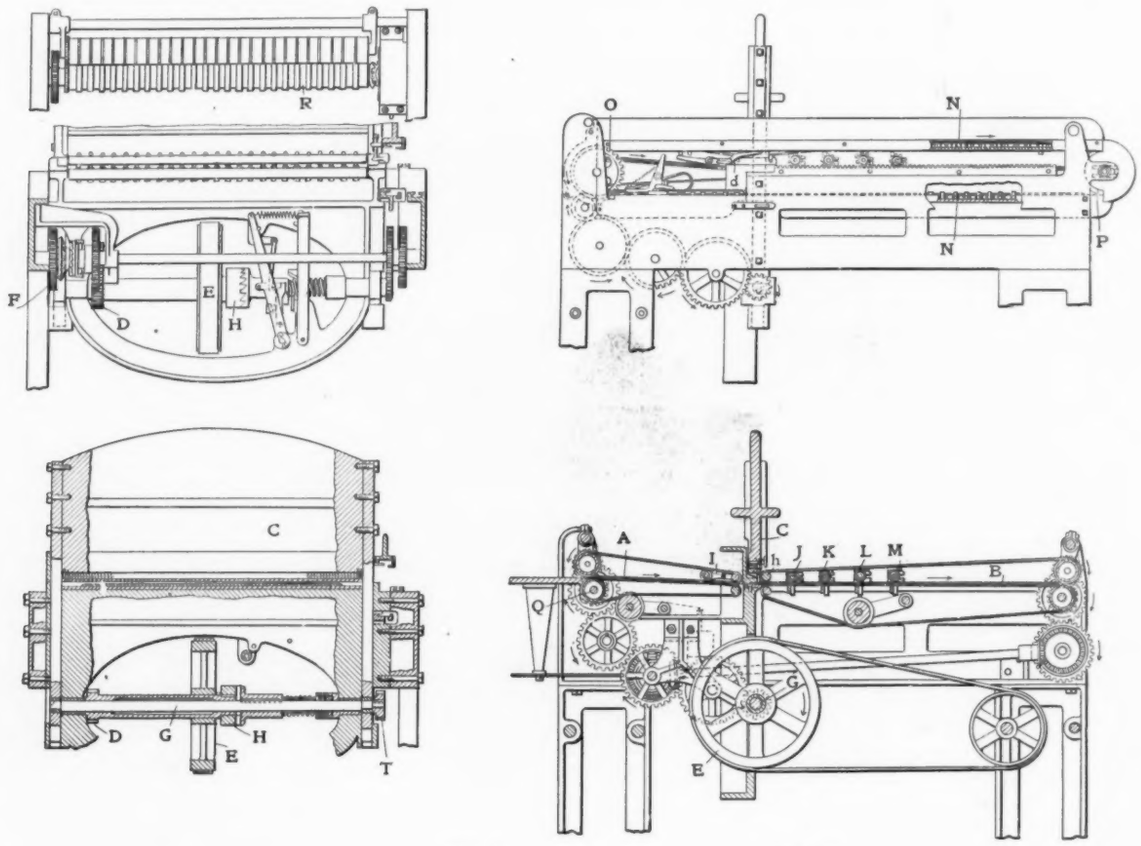


FIG. 3

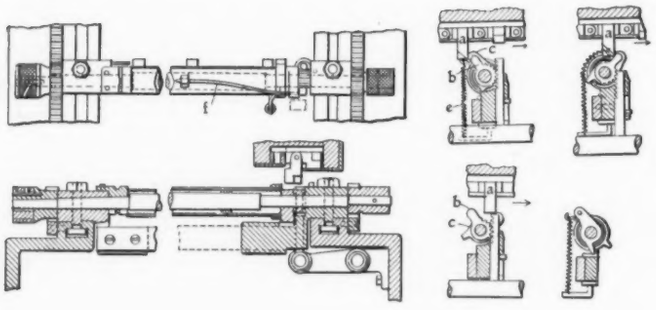


FIG. 4

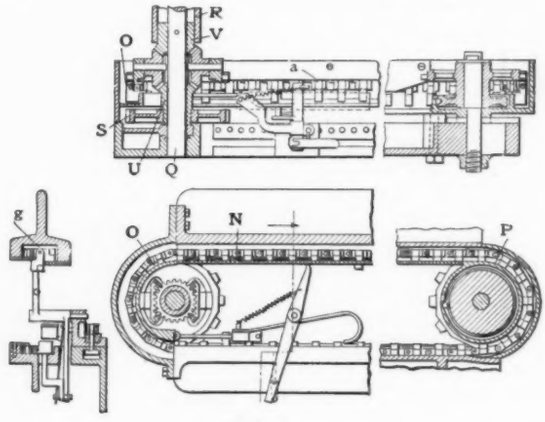


FIG. 5

SHOWING CONSTRUCTION OF PERFORATING MACHINE

chain again becomes a simple sprocket chain.

It should be noted here that the rear gages are turned backward to normal or open position after dog *a* has passed rocker *c*, by spring *e*. Also, attention is called to the fact that rocker *c* is connected to the gage by a wire spring *f*. This flexible connection allows the gage to be rocked down to its positive stop with an easy, constant pressure and also permits the rocker to be depressed still farther to free the end of the dog when the chain again starts forward. The outer portion of the dog where it contacts with rocker *b* is cleared at the heel as shown, so that while the gage rocker *c* is held as long as the chain is stationary, *b* is merely turned ahead by the dog sufficiently to start the clutch into engagement and then released.

PROVISION FOR DIFFERENT LENGTHS OF SHEETS

It is obvious that for each sheet or thin pile of sheets as fed into the machine there must be a corresponding dog thrown into working position in the chain. It is also evident that the distance between any two consecutive dogs so set must be equal to the length of the sheet plus a small amount (say 2 inches) for clearance between the ends of the sheets. As already stated, the links are one inch pitch; hence the dogs are carried at intervals of one inch. To throw the right dogs into working position for any given length of sheet the mechanism seen in Figs. 2 and 3, near the left-hand or front end of the machine, is employed.

The graduated plate shown in the halftone is marked off in even inches and above this plate is an adjustable bracket which may be set at any point along the line of graduations. The bracket carries a rocking mechanism one member of which extends under the lower line of the chain while another member extends upward to a point where it may be struck by any trip dog which happens to be snapped into working position. Imagine the bracket set at "28" and a dog in front of it turned into operative position: Upon this dog striking the upper arm in the bracket mechanism the lower arm will throw into operation another dog twenty-eight links removed from the first one. And when this second dog arrives at the contacting arm above, a third dog still twenty-eight links behind it will be set; and so on so long as the machine is in operation. Each dog does its work as it passes along over the gage and resumes its normal position in the chain upon the fulfilment of its functions. If the bracket is set at "20" the first dog sets the 21st, and so on, the spacing being in accordance with the graduated scale. Where lengths under 14 inches are to be handled the bracket is set to a multiple of the required length; thus 10-inch intervals may be obtained by adjusting the bracket to "20" and then setting at the start two dogs ten links apart. These then automatically cause two more to be set at 10-inch intervals, the process repeating itself without attention so long as the machine continues running.

The construction of this trip-setting device is shown in somewhat modified form in Fig. 5, and it will be noticed that the guide channel *g*, in which the chain operates, has retaining slots both for the dogs that are set for working and for those that remain in normal position. Preliminary to passing up around the front sprocket *O* the dogs are held in the required position in their blocks by a cord which may be seen in Fig. 2.

This cord passes through a hole drilled obliquely through the bracket and its rear end lies to the front of the chain while that portion in front of the bracket forms a stop against which the dogs slide until they pass into their guide channel. The cord is permanently secured at both ends independently of the bracket and interferes in no way with the adjustment of that member.

In order that there shall be no strain on the paper and a consequent tendency for the latter to "creep" during the perforating operation, the roll *h*, around which the front loops of the rear-feed strings pass, is automatically lifted just prior to the descent of the punches, thus freeing the work entirely from the pull of the strings, until upon the upstroke of the punch slide the roll again drops into position.

THE PUNCHES

The punches are made of special steel wire with a head formed on one end. They are dropped into their holder in the slide from an opening at the side and then a clamp plate is slid into the opening, the lower edge forming an abutment for the upper ends of the punches. The clamping strip is made in sections about 4 inches long and if a section of the line of perforation is to be left blank the corresponding clamp strip is removed, thus allowing the punches in that division of the slide to lift freely upon striking the paper, without even marking the surface. There are in the entire length of the slide about 450 punches; these are in two lengths, with a difference of about 1/16 inch, to make the work of perforating easier. They project but a short distance below the holder, or just enough to pass through, say from half a dozen to a dozen sheets of ordinary thickness.

Special Agent Harry R. Burrill, writing from Fremantle, Western Australia, says that there is a good demand for first-class windmills in that country and that the American windmill seems to be the favorite and to be preferred over those which are made in any other country.

Moody's Magazine prints it "compressed-air."

Electric Motor Drive

BY GEO. H. SCHAEFFER

Of recent years engineers have discussed the power lost in shafting and belting, the great amount of space taken up by the same, the high cost of maintenance, the liability of breakdowns and the inflexibility of belt-driven machinery.

It is the purpose of this article to give a short comparison between belt-driven and motor-driven machinery, and also to give the advantages of the latter.

With the advent of the electric motor there came a probable solution for belt drive. Up to 1900 few manufacturers had adopted motor drive and its use was not advocated. At the present time, however, the motor has reached a high state of perfection and is vastly superior and much cheaper than it was several years ago. Since 1900 practically all large manufacturers have adopted it.

The question which first concerns the manufacturer is: What advantage is there in the use of the electric motor, and what is the cost of its installation as compared with shafting and belting? and I will consider the operating expenses under each class of drive, viz., *motor* and *belt*.

ANNUAL FUEL EXPENSE

This depends on the efficiency of transmitting power to the machines. The average loss of power in belt and shaft transmission for about 50 shops, half in France and half in the United States, was 40 per cent. of the power generated, making the efficiency 60 per cent. On the other hand, with electric drive, allowing 93 per cent. efficiency for the generator, 80 per cent. for the motors, 95 per cent. for transmission or loss in line (which are quite low) we get an efficiency of 70 per cent. This means an increase of 10 per cent. over belt drive and consequently a reduction in the fuel bill of 10 per cent.

ANNUAL EXPENSE OF ATTENDANCE

It is a well known fact that belting must be adjusted about once a month and the shafting be cleaned weekly. With a motor one oiling lasts from two to three months and no attendance is required except a man to start and stop it and the man in charge of the machine does this. This makes the cost of attendance of the motor almost negligible.

ANNUAL COST OF REPAIRS

With an engine and intermediate gearing, bearings must renewed, the shafting inspected and the belting repaired or renewed frequently. On the other hand, with motor drive, having an engine coupled to a generator, we avoid this trouble and expense. As far as the motors are concerned the repairs are negligible. Here is an instance: In the shop of the Allgemeine Electricitäts Gesellschaft, where 500 motors are installed at the present time, only 39 had to be repaired in 30 months.

FREQUENCY AND DURATION OF BREAKDOWNS AND THE EFFECT ON THE PLANT

A breakdown in any shop results in a loss, and the larger the shop the greater the loss. With motor drive breakdowns are reduced 75 per cent.

In a modern shop the greatest item of expense is the wages. On an average, three men are employed per horse-power. Anything which will increase the output per horse-power without increasing the wage item is of the greatest importance. The question as to the advantage of electric drive hinges chiefly upon the effect on the output of the product per man per machine. This in turn depends on:

I. The general arrangement of machinery to facilitate the handling of work. With shafting the machines must be placed with regard to the line shaft. Motor-driven machines can be placed in any convenient position.

II. Clear headroom for use of electric cranes and small hoists. With belt-driven machines, traveling cranes and small hoists are at a great disadvantage.

III. Light and cleanliness. The output or work per man greatly depends upon his surroundings. The lighter and cleaner his surroundings, the more pleasant will be his disposition.

IV. Speed control. It is absolutely necessary that the speed of a machine be under perfect control, and that the speed be capable of variation over a large range. The control of speed is accomplished more quickly and at less expense with the motor than by any other method.

V. Use of electricity for other purposes than power. Besides running machinery we can use electricity for lighting, welding, brazing, soldering, etc. This varied usefulness tends to foster these different operations and thus increase the scope of work in any one shop.

Another advantage is that for a given horse-power of engine more machines can be used with electric drive than with belt drive. This follows from the fact that a certain number of machines are idle all the time, but their shafts and belts are continuously running and therefore absorbing power. With the electric drive this power can be used to drive extra machines.

Experience has shown that the average load on the generator is 20 per cent. and maximum load 35 per cent. of the motor rating. Therefore, to get full load on the generator we must install five times as much motor horse-power as generator horse-power. An example of this is shown by the installation of electric drive at the Baldwin Locomotive Works, where the capacity of the generators was estimated at one generator horse-power for every four motor horse-power.

In short, the advantages of motor drive are the increased output per man, good speed regulation and greater efficiency of machine drive. In regard to first cost it may be stated that in some cases, for example in a mill, the first cost of electric drive is cheaper than belt drive. On the other hand, in a machine shop electric drive is the more expensive. It has been estimated that the saving in power by using motor drive will pay the cost of the plant in from one to five years.

Legal Notes—Cases of Interest to Manufacturers and Employees

BY E. P. BUFFET

WHETHER OR NOT A CERTAIN BLUE-PRINT CONSTITUTED A WARRANTY

An interesting legal controversy has been waged in Massachusetts between a machinery company and a chemical company. The facts seem to be about as follows: The machinery company sold the chemical company a machine containing a "basket," which burst and fatally injured an employee of the latter concern. The chemical company, having paid a resulting claim for damages, sought to reimburse itself from the manufacturer. During a delay in the delivery of the machine, the purchaser had obtained from the maker a blue-print of it, showing a 24-inch driving pulley, the speed of the countershaft on which it was mounted being marked at 275 revolutions per minute. The speed of the basket was marked at 1320 revolutions per minute. The chemical company, therefore, eventually had its mill work proportioned to a pulley of this size. The machine came, however, with a 15-inch pulley, and it is to the resulting inordinate speed that the accident is evidently attributable. It is claimed, without contradiction, that the chemical company's mill architect did not start to plan the shafting and pulleys until the machine had been for two months or more in its possession.

The chemical company contends that the blue-print constituted an implied representation, or warranty, that the machine would have a 24-inch pulley. The court "greatly doubts" whether this position is tenable. There was uncontradicted testimony by the machine company's manager that such machines were manufactured and sold in the general market to be set up and connected in the factory by the purchaser; that no particular size of pulley formed a part of the machines, but a driving pulley of some size was usually sent with each, according to the given speed of the main shaft; that in this case no particular size of driving pulley was asked for and the machine company knew nothing about the speed of the chemical company's engine or shaft and had nothing to do with setting up the machine; that blue-prints were commonly furnished to any inquirers, and he, the manager, did not know until after the accident about this one having been sent.

Yet, even assuming that the blue-print did, within the circumstances, constitute an implied undertaking that the pulley would be of the size shown, the Supreme Court rules against the chemical company, holding that it acted negligently and therefore cannot recover.

78 N. E. Rep., 419.

WHEN WORKMAN ASSUMES RISK OF MACHINE IN CASE OF UNFULFILLED PROMISE TO REPAIR

A workman in a tube mill brought action against the owner to recover for injuries caused by a defective machine on which he had been engaged. His own version of the story was, that when he had called the attention of the superintendent to an obvious derangement in the machine, he had been told: "You go right ahead with the work. We are overloaded with work, and noon hour I will fix this for you." The New Jersey Court of Errors holds that, if the superintendent spoke as asserted, the workman's resumption of work on the machine after the time for repair had expired, he knowing that it had not been repaired, would suffice to throw the risk upon him. On the trial of the case, the chief justice, who presided, holding the alleged promise to be definite as to time of performance, laid down the following rule, which the appeal court, after a long review of the authorities, sustains as correct:

"Where the master says that he will repair the machine, or have it repaired, at a specific time, the employee is entitled to continue to operate the defective machine at the master's risk until that time has elapsed; but if, after that time, the master has not made good his word and made the repairs, and the employee still continues to operate the machine, the risk shifts, and the employee assumes it, relieving the master."

63 Atl. Rep., 719.

DELAWARE LAW DOES NOT PRESUME A DEFECT IN A MACHINE TO BE CHRONIC

The imperfection of a spark arrester on a traction locomotive was recently under dispute in Delaware between the owner of the engine and the owner of some cordwood. It was claimed by the latter that "divers sparks of fire and divers portions of fire and igneous matter passed and flew out of the said steam locomotive engine and communicated to the pine wood, which then and there became ignited and became and was destroyed."

In seeking to prove that the engine sparked, a witness was asked how he had seen it acting the afternoon before the fire. The admission of such evidence was objected to and the chief justice sustains the objection, with the following remark:

"The courts have very often ruled in damage suits that in order to admit testimony as to the condition of a machine, for instance, a few days prior to the happening of the injury resulting from some alleged defect therein, the

party must be prepared to follow it up and show that the machine was in the same condition as at the time of the injuries. It might be so close to the time as to make it admissible. But in this case we think it is too remote."
63 Atl. Rep., 686.

An Evening School with Credit on the Term of Apprenticeship

EDITORIAL CORRESPONDENCE

The Young Mens Christian Association of Sherbrooke, Que., conducts an evening school during the winter months designed more especially to meet the needs of apprentices in the machine shops of the town. Much of the technical work during previous winters has been in the hands of H. V. Haight, engineer of the Canadian Rand Drill Company, who has been so successful with it that he has been given general charge of this branch of the school work.

As an added incentive to apprentices to join the school arrangements have been made with the machine shops of the town whereby the school work is credited to the apprentice and his term of apprenticeship is correspondingly shortened, the idea being due, I understand, to Mr. Haight. Following is an extract from the circular issued by the school showing the conditions under which the credit is given:

Apprentices will be credited for attendance at educational classes upon the following conditions:

1. Credit will be allowed on the basis of one day deducted from the regular term of apprenticeship for each session of class attended.

2. The classes which the apprentice may enter, under this plan, are subject to the approval of his employer. The total credits allowed in any one year shall not exceed 30 days.

3. The apprentice shall obtain from his employer a certificate to attend each class for which he desires credit, and shall hand it to the teacher at the beginning of the term.

4. At the end of the term the teacher shall return the above certificate, properly filled out, directly to the employer.

5. Except at the option of the employer, no credit will be allowed for attendance averaging less than 50 per cent.

6. Credits will be allowed at the end of each year of apprenticeship.

7. The apprentice agrees to diligently prosecute the studies of the classes selected. F. A. H.

The Bair & Gazzam Manufacturing Company, of Pittsburg, Penn., has recently completed what is probably one of the most noteworthy stamp mill that has ever been constructed. In this mill there are no less than 321 stamps and each stamp is about 1500 pounds in weight.

THE MANUFACTURE OF TOOL STEEL*

Some Facts Not Published in the Text Books

BY E. T. CLARAGE.

As I understand it, I have been asked to prepare a paper on the manufacture and use of tool steel, but I find this subject much too broad to be covered or even touched upon in one paper. With your permission I will confine myself to some facts in connection with the manufacture of tool steel which are not published in the text books.

As a usual thing, when a man starts to talk about his own particular line of business, he calls attention to the perfection of the methods and the product.

Certainly the manufacture of tool steel goes back far enough to entitle it to veneration for its antiquity, if nothing else, and it may surprise you to hear from me, a crucible-steel maker, what might be called heresy by some of those who are older in the business.

A man who is honest with himself, and thoroughly familiar with the steel-making industry, must admit, however, that nearly all the efforts to reduce steel making to scientific principles have been applied to the bessemer and open-hearth methods. And there are very good reasons for this, as I will try to explain to you. I was reading the other day some facts in connection with the life of Sir Henry Bessemer, and it is astonishing, when you consider the steel industry today, that the bessemer-steel process was given to the world only so short a time ago as the year 1856.

THE FIRST TOOL STEEL

No one knows how, when or where the first tool steel was made. Without doubt, it was the result of an accident. Some primitive blacksmiths found that from contact with the fuel under certain conditions, iron became much stiffer, and that it would become very much harder if dropped into water at a red heat. By further experiment it was evidently found that iron bars would best take on this ability to harden if packed in muffles with charcoal, and kept at a high heat for a number of days. They had no idea whatever that they were carbonizing their iron; in fact, did not know that there was such a thing as carbon as we know it.

The science of chemistry itself is only about a hundred years old, and the old blister-steel makers of Sheffield had nothing to guide them, and had no idea what they were doing. It is no wonder that they did not know carbon as we know it. It would have been hard for them to believe that a diamond, a flake of graphite and a piece of charcoal are chemically the same substance. But this is a very simple test for a chemist. He burns the same weight of each of these substances in an oxygen gas carrying the product of combustion through a tube containing caustic potash, which has the property of absorbing all of the carbon-dioxide gas produced. The tube or bulb containing the potash is carefully weighed beforehand in each case, and again after combustion has taken place, and in the case of the diamond, the graphite and the charcoal, the same amount of each having been used, there will always be the same amount of weight added to the potash according to certain fixed rules, and there will be nothing more and nothing less.

BLISTER STEEL

Blister steel was simply iron carbonized the same as you case-harden your link motions, except that it was left in so much longer that the carbon went in much deeper. You occasionally hear some old fellow speak of the good old days when they had blister steel to make tools of. I only wish he had to make a tool out of some of it. The truth is that it was generally full of seams and the carbon was very unevenly distributed. The center of the bar generally had little or no carbon, and one of the first improvements was to turn a bar over and weld it upon itself, which allowed the carbon to soak through a little more uniformly, and thinned out the soft streak in the center.

This was called single-shear steel, and when this bar was again doubled over and welded on itself, it was called double-steel.

Some time about 1760 one company in England astonished the rest of the blister-steel makers by producing a bar that would harden uniformly all the way through. The story is that the process was kept a secret until a competitor sought shelter on a cold wintry night and was allowed inside for humanity's sake. His eyes saw what to him was a wonderful process. He found that they were packing the broken pieces of blister steel in a crucible and melting it. This was the beginning of the present crucible process, and really very few changes have been made since that time.

It may be said that there have been only two changes of any importance in the method of making tool steel. One concerns the type of furnace used, and the other is the direct process of carbonizing. All of the melting was originally done in coke holes, the same as brass is melted today. By the way, any of you can make steel in your own shop if you have a brass furnace. Just put a hundred pounds

*An address by the president of the Columbia Tool Steel Company, delivered before the Northwest Railway Club at Minneapolis.

of good Swedish iron into a new No. 60 crucible, putting a cap over the top to keep out any gases which might carry any impurities into the steel. You want to put in one ounce of good clean charcoal to each four points carbon you want to add to your mixture, and that is about all there is to it.

But you would find this a very slow process, and it would bother you a good deal to keep the heat just right. The amount of heat must be just as carefully regulated as in baking bread. If you were to pour out your steel as soon as it is melted, the chances are that it would be all honeycombed. It must be held at a high heat for a certain length of time to work off the gases, or must undergo what we call "killing" the steel. This was a hard thing to do with the old-style coke furnaces, but with the invention of the Siemens-Martin regenerative gas furnace, it was made possible to regulate the heats perfectly.

THE SIEMENS-MARTIN FURNACE

As you know, the bunsen gas flame is limited to a temperature of about 1800 degrees. The construction of the Siemens-Martin furnace is such that both the gas and air are superheated before they are ignited. On both sides of the "pot holes" are two tunnels built of the best quality of fire brick. These tunnels are from twenty-seven to thirty-six inches wide, and about nine feet deep. The upper part is filled with brick checker work, the gas coming in through the one nearest to the pot holes, and the air through the other.

This gas and air unite just as they go into the pot holes, and after giving off part of their heat to the crucible in which the steel is being melted, the flame passes out down through the checker work on the other side of the furnace. By an arrangement of valves, the furnace is reversed every fifteen minutes, and in this manner the heat stored up in the checker-work will heat the in-coming gas and air to about two thousand degrees, to which we add the effect of a bunsen flame of about eighteen hundred degrees more. Every steel maker of any consequence now uses this type of furnace for making crucible steel.

The other change I referred to is this. Up to within the past twenty-five or thirty years, it was the practice to first carbonize the iron in the shape of blister steel. This was done by packing the iron bars in retorts, a layer of iron and a layer of charcoal, until the retort was full. A great fire was built up on the outside of this retort, until the entire mass was at a good red heat which was kept up for several days. This long continued heat raised a heavy scale on the iron and the blistered surface gave it its name of blister steel.

DIRECT CARBONIZING

A few years ago someone who was a little more daring than the rest figured it out that the charcoal could just as well be put right into the crucible with the iron. The reason it had not been done before was probably because everyone thought that the charcoal would all burn up the minute the crucible was put into the furnace. I told you that the science of chemistry is only about a hundred years old, but the practical application of chemistry to the arts is not over fifty years old.

Chemistry teaches us that in order to burn up this charcoal, we would have to supply oxygen in the proportion of thirty-two parts by weight to each twelve parts of carbon. The amount of oxygen contained in the free air in the crucible is too small to enter into any calculation; consequently this charcoal simply gets red-hot without being consumed.

A good illustration of this is the carbon in an incandescent lamp, which is not consumed as long as the oxygen of the air is kept away from it.

When the iron is brought up to a certain temperature it becomes very hungry for carbon, and the carbon in the charcoal is then taken up very rapidly. When this direct-carbonizing method was first used I remember a certain English steel maker came out with a publication condemning it thoroughly, and saying steel could not be made in that manner. This same man is still making steel, and is now using this process the same as everyone else.

SWEDISH AND AMERICAN IRONS

One thing of great importance was learned from experience, and that was that certain kinds of iron made good steel, and others seemed for some reason unfit for the purpose. Mind you, they knew very little about phosphorus and sulphur, the two deadly enemies of steel, and it was only from many experiments that they found that certain grades of Swedish iron gave them the best results. This knowledge became tradition, and to this day we are still guided by it.

Chemistry has taught us to compute accurately certain known impurities, such as phosphorus and sulphur, but to this day we cannot tell why these Swedish irons are better than irons produced in this country of, as far as we are able to determine, the same chemical analysis.

When nature made those deposits of iron in Norway and Sweden it so happened that there was little or no phosphorus or sulphur present to contaminate it, and so far these conditions have not been discovered anywhere in America.

We used to hear a great deal about "bessemer ore." By this term was meant an ore running not over one-tenth of one per cent. phosphorus, up to which limit it could be safely used in the bessemer process. Some of the Southern irons carry as high as two-tenths of one per cent., while the Swedish irons we have been talking about many of them carry very little over one one-hundredth of this impurity.

Starting in with the purest American ores, chemistry has taught us how to eliminate nearly all of these impurities; but it would seem that the immense doses of physic required must weaken the structure of the material, or else the difference is due to elements which cannot be found by analysis.

Prof. John W. Langley tells me that he made a careful study of this subject some years ago, and from the fact that the American irons are all higher in nitrogen, he concluded that possibly this accounted for the difference. It is still more probable that oxygen, or the affinity of the iron for holding oxygen in solution, may have a much greater effect; but so far chemistry has not yet provided us with a reliable method for oxygen analysis in steel, and we are very much in the dark on this subject. Going back to nitrogen, let me quote an article from one of the technical journals, which reads as follows: "*Stahl und Eisen* gives the results of some determinations on the influence of nitrogen in iron, made by H. Braune, who discovered alterations in the physical properties of the metal. An iron wire of the composition of 0.08 per cent. carbon and 0.027 per cent. nitrogen was nitrated with dry ammonia gas.

"After nitrating, the percentage of nitrogen was found to be 0.267 per cent. The original wire stood 15 or 16 deflections. The nitrated wire was unable to stand more than two or three."

The chemical formula for ammonia is NH_3, or 14 parts by weight of nitrogen to three of hydrogen.

Whether it is either of these elements or a combination of both that makes the difference, I do not know; but I do know that we would not pay the high price for this special Swedish iron if we had not proven to our own satisfaction that the difference does exist.

With the invention of the bessemer and open-hearth processes it became absolutely necessary to call in the aid of the chemist for two particular reasons. One was that the steel was made in such quantities that the steel maker could not afford to let it go wrong, and the other was that this same immensity of production made it necessary to use these low-grade ores, which were so much more abundant.

THE CRUCIBLE-STEEL MAKER

But the crucible-steel makers kept along in the same old rut, and in undisturbed satisfaction with themselves. Prof. Henry W. Howe, after an investigation of their methods as far as they would permit, paid his respects to them on page 80 of Howe's "Metallurgy of Steel" in the following words:

"The solution of the difficult problem of adapting to their use these alloys whose properties seem to vary with their composition, according to the most complex and unguessed laws, has been chiefly intrusted to men utterly unfitted for it by

nature and training. Groping in the dark often with neither adequate chemical or physical testing, their jealousy and narrowness have too often thrown Chinese walls around their establishments, keeping knowledge out far more than in.

"Each crucible-steel maker, hugging his own ignorance, lest his trivial secrets, or lack of them should leak out, often refused to advance lest his neighbor should advance too."

The usual practice was to have one man whose business was to put up the "mix." Part of this work was done in what they call the "medicine" room, which was kept under lock and key. As a rule, the man in charge of the secret "mix" was a man without any education, and with no knowledge whatever of the effect produced by various materials. His secrets were generally handed down from his father and grandfather, and he weighed out his material in certain proportions, because his father told him that was the way to make good steel.

Without doubt, most of the secret medicine did no good whatever, and probably did no particular harm as it passed off in a gas before the iron was melted. I would not be surprised if the left hind foot of a rabbit had been used many a time, but presume this did not become a popular formula on account of the supply of rabbits being limited.

You would think we had gotten past that age; but it seems not. Every little while someone bobs up with a secret dope for making good steel out of poor iron; but it cannot be done.

TOOL-STEEL "MIXES"

Here is an article that I cut out of a trade journal the other day as a curiosity. The author attempts to give some good old "mixes" for making tool steel:

Bessemer-steel scrap, 30 pounds; crucible-file scrap, 30 pounds; miscellaneous steel scrap, 30 pounds; charcoal, 4 ounces.

Here is another by the same authority: Muck iron (American), 20 pounds; boiler punchings, 35 pounds; miscellaneous steel scrap, 45 pounds; charcoal, 10 to 14 ounces; 70 per cent. ferro-chrome, 2 ounces.

Now I want to tell you about how I would figure out that first mixture. As I said before, the limit for bessemer used to be one-tenth of one per cent. phosphorus, with sulphur about the same. He starts in with 30 pounds, or nearly one-third of his mixture bessemer steel, containing probably 0.10 per cent. phosphorus, one third of which would give him over three points phosphorus right there. His file-steel scrap would carry anywhere from 0.04 to 0.06 per cent. phosphorus, which would give him nearly two points more. Then his miscellaneous steel scrap might be any old thing, which would probably add at least two points more phosphorus, bringing the total up to about 0.08 per cent. We limit the phosphorus in the lowest grade of tool steel that we make to less than one-quarter of this amount, or under 0.02 per cent. I presume his grandfather told him these "mixes" couldn't be beat.

This is a fair sample of how much these secrets amount to. Almost every conceivable material has been tried in with the iron at some time or other, and curious to relate, men are still trying blindly and without reason, hoping to accidentally discover some new and wonderful "mix" that will convert viciously poor iron into reliable tool steel.

I know of one Pittsburg concern which so carefully guarded its secrets that there was only one man about the place who knew what was called the secret mix. This man went on a strike, and the company pretty nearly went out of business for a time.

Making up formulas in this crude and unscientific manner resulted in some makes of steel being particulary bad, though it must be admitted that some of the tool-steel makers, backed by the accumulated experience of a century, did produce remarkably good steel as long as they continued to use the best grades of Swedish iron.

THE ADVENT OF HIGH-SPEED STEEL

Such advances as have been made in crucible-steel making have been developed first of all by outsiders, and gradually forced onto the steel makers in spite of themselves. The modern high-speed steel is a good illustration of this, the development of which was brought about by two men who were not directly connected with the tool-steel branch of steel making.

One of the large open-hearth steel concerns, which furnished a great deal of its material rough-turned, found that its forging department could turn out a great deal more material than its machine shop could take care of.

Possibly by accident, possibly by intention, it seems that they burned the end of some of their self-hardening tools, and they found that the steel would then do a great deal more work, and at higher speeds.

You see we steel men had gone around for the last twenty years or so, telling people to use low heats on all their steel, and this shows how little the steel makers themselves really knew. We did not know that the rules governing the use of straight carbon steels might be directly contrary to what these tungsten steels required; but such seems to be the case. When this fact became apparent, we immediately asked ourselves: "What does this high heat do to the point of the steel? Does it burn something out, and if so, what?" Carbon is, of course, the most combustible element in steel, and we reasoned that heating the point of this steel till it fused must burn some of the carbon out.

So starting in with that as a basis, we reasoned that if it was a good thing to burn the carbon out, why not leave it out in the first place?

CARBON AND TUNGSTEN

The regular self-hardening steel contained about 9 per cent. tungsten, the theory being that the function of tungsten was to hold a larger percentage of carbon in the combined condition.

If you put much over 1½ per cent. carbon into steel, you can expect a part of it to be precipitated in the form of free carbon, but with a steel containing much tungsten it is possible to have combined carbon even as high as 3 per cent. As you know, cast iron contains from 3½ to 7 per cent. free, or graphitic carbon. Wrought iron is iron from which this carbon has been removed. The difference between free and combined carbon can be illustrated in this way. Suppose you put a teaspoonful of sand in your coffee. You can stir it around as much as you like, yet the particles float around undissolved. This represents free, or uncombined carbon as it exists in cast iron. But suppose you take a teaspoonful of sugar instead. The particles dissolve, and are taken up in solution. This illustrates combined carbon as it exists in steel. So in developing the modern high-speed steel the amount of carbon was gradually lowered, and other hardening elements not so easily affected by heat were increased until a steel was produced containing about twice as much tungsten as the regular self-hardening steel and carbon was reduced to about half of one per cent.

Prof. John W. Langley made quite a study of these alloy steels a good many years ago. I have a report somewhere of an address he delivered before the American Society of Mechanical Engineers, in which he speaks of tungsten as having the ability to hold a larger amount of carbon in the combined condition, and stating also that tungsten itself was not a true hardener. Tungsten certainly does seem to have a great effect on carbon, as is shown by grinding a piece of self-hardening steel on an emery wheel. With a straight carbon steel the carbon particles ignite from the frictional heat and explode in a brilliant shower of sparks. When tungsten is present, so firmly does it hold the carbon, that the particles do not ignite and we get only the dull red sparks. We made some steel the other day containing less than 1 per cent. tungsten, yet its presence was easily shown by touching it to the emery wheel.

In further proof of his theory Professor Langley said, "I have made a steel containing as high as 25 per cent. tungsten, and very little carbon, which was so soft that it could be readily touched with a file." If he had put a tool made of that steel into the fire and accidentally burned it and then tried it to see what it would do, we would have had the modern high-speed steel at least twenty years ago.

LOW HEAT FOR CARBON STEEL

Now in speaking of these high heats that must be used on high-speed steels

do not forget that the fact remains that regular carbon tool steel must be heated at a low heat to harden. The grain of the steel always records the last heat used. If it looks like a piece of cast iron it has been very badly overheated, no matter if the blacksmith does tell you that he only had it at a cherry heat. Perhaps he was brought up on white cherries. The grain of the steel always tells the truth. If you have broken tools, first of all look at the grain shown in the steel. If it is coarse, just take the same piece and put it back into the fire and heat it at a very low red, harden it and then look at the grain. That will tell the story.

A piece of tool steel properly hardened must always show a much finer grain than the unhardened bar.

About two years ago, when speaking at the blacksmiths' convention at Buffalo, I told them that there was one very common fault in railroad blacksmith shops, in giving the tool fire to the oldest man in the shop.

In most cases he has worked upon all his life, and his eyes are in no condition to judge heats to a nicety. I suggested that they give the tool fire to the youngest man in the shop, and not necessarily a full-fledged blacksmith. Take some young fellow who is willing to learn and will do as he is told, and show him the effect of heat on steel by breaking the piece after hardening to show the grain.

I know a young man who was tool dresser in one of the Western railroad shops some years ago, and who used to overheat every piece of steel he got hold of. The foreman took him in hand and got him so much interested that he became one of the most expert steel workers, and for several years he has occupied the position of instructor in one of our large universities. You will find the young man willing to learn and he is quick to become interested, but it is hard to teach an old dog new tricks.

THE FUTURE OF CRUCIBLE-STEEL MAKING

To go back to my text, the process of crucible-steel making is simplicity itself. There is nothing to be eliminated by chemical reaction, and you get out of the crucible just what you put into it.

Science ends where secrecy and mystery begin. The duty of science is to simplify—to reduce to first principles, and when its light is allowed to shine in, all these dark secrets dissolve into nothing.

The crucible-steel maker of the future must have something better than tradition to guide him. In the first place, and above all, he must use good material. This is the foundation for everything that comes afterward. Then he must make up his standards, holding the impurities in each grade as low as his costs will permit him. It is then a very easy matter to figure out his formulas, or, as the old-fashioned steel maker calls it, the "mix." All he has to do is to make a careful analysis of each grade and kind of material he is using, then make up his combinations so as to produce the analysis required.

Crucible-steel making offers great opportunities to the investigator. The material is made in such small units that it is possible at a very small expense to work out new combinations suggested by an ever increasing knowledge of chemistry.

Although nearly all of the crucible-steel makers still follow the old methods, there are a few today who are conforming their practice to scientific principles with as much care and research as has been expended on the bessemer and open-hearth processes.

First of all this will result in the steel maker knowing just what he is doing and will certainly result in a uniformity of product not heretofore obtained. The final aim, as well as the final result, will be, not to cheapen the product, but to work out new chemical combinations with probably iron as a base, which may be as far ahead of our modern high-speed steel as it is ahead of the old blister steel of our grandfathers.

Civil Service Examinations for Draftsmen and Laboratory Assistant

The United States Civil Service Commission, Washington, D. C., announces an examination on November 21, 1906, to secure eligibles from which to make certification to fill two vacancies in the position of mechanical draftsman, $1500 per annum each, in the Engineer Department at Large, one at Wheeling, W. Va., and the other at Chattanooga, Tenn., and vacancies as they may occur in any branch of the service requiring similar qualifications.

The examination will consist of the subjects mentioned below, weighted as indicated:

SUBJECTS.	WEIGHTS.
1. Machine design	30
2. Drawing	30
3. Shop work	10
4. Training and experience	30
Total	100

The appointee will be expected to design the details of simple but heavy machinery and castings; should be familiar with machine shop, foundry and forge work; should have had some experience in the drafting department of a machine shop; should be able to determine the dimensions of machine parts when the conditions are given, and calculate the stresses and weights. Experience and qualifications along these lines must be indicated in the application.

The Commission also announces an examination on November 14 for laboratory assistant (qualified in practical optics), at $1000 per annum, in the Bureau of Standards, and vacancies as they may occur in any branch of the trade requiring similar qualifications. Applicants must show in their applications that they have had at least five years' practical experience in glass blowing, consisting of the construction and designing of all sorts of vacuum tubes, glass measuring apparatus, and the most intricate physical and chemical apparatus. Experience in commercial glass blowing—bottles, window glass, etc.—will not be accepted.

The examination will consist of the subjects mentioned below, weighted as indicated:

SUBJECTS.	WEIGHTS.
1. Education and experience (rated on application form)	50
2. General physics	25
3. Practical optics (which includes skill in glass blowing, consisting of the construction and designing of all sorts of vacuum tubes, glass measuring apparatus, and the most intricate physical and chemical apparatus)	25
Total ratings	100

Age limit, 20 to 35 years on the date of the examination.

Applicants must show that they have been graduated from colleges or technical schools, or that they have attained an equivalent education. The examinations will be held in various cities throughout the country, of which a list may be obtained upon application to the Commission.

Not in the New Building

Although it is announced in the recent issue of the "Transactions of the American Society of Mechanical Engineers" that the coming December meeting of the society will be held in the New Union Enginering Building, yet we are informed that it will not actually be held there, owing to a failure to secure an agreement to such a program by all the interested societies. The building will, however, be open for the inspection of interested members during the coming meeting, and the dedicatory exercises will take place some time later.

Selling Magazine

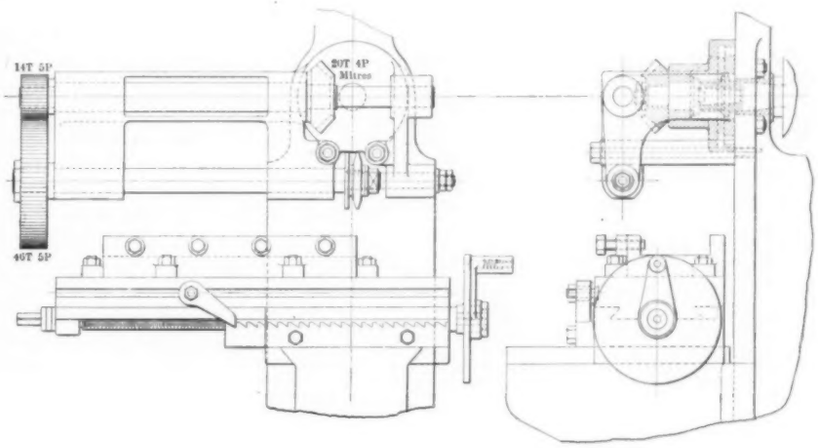
Some time ago we noted the advent of a new publication in the field of specialized journalism, called *Selling Magazine*. Its name is broad enough to cover any kind of selling, and of course it may eventually take up and discuss the art of selling circus tickets and fish. But so far it discusses mostly the art of selling those things in which readers of the AMERICAN MACHINIST are interested, and the work it is doing is, in our opinion, most excellent. There is also plenty of evidence that this good work is fully appreciated by those for whom it is intended. They contribute articles and interviews, subscribe and advertise—the three things necessary for the success of any journal.

CORRESPONDENCE

Discussing Phases of Machine Design and Construction

A Rack-Cutting Attachment for the Miller

The drawing shows a milling machine arranged for rack cutting. The first racks we cut were done on a milling machine, using the table feed, with the cutter mounted directly on the arbor; it was possible to move the cross slide only about 4 inches, so that this was the greatest length that could be cut without shifting and reclamping the blank. It can be better imagined than described what a slow process this was, but it represented the sum total of our rack-cutting equipment.



A RACK-CUTTING ATTACHMENT

Our next attempt was with a circular cutter similar to the one used with the Fellows gear shaper. This cutter was used on the planer on a similar fixture to the one described at page 54, Vol. 28, Part 2; but owing to the springing of the cutter when applied to the planer we soon gave it up.

Our next experience was with a miller which had a rack-cutting attachment, one of the usual kind, with a small pinion on the cutter spindle so that any length of rack could be cut. The pinion in this particular case had 16 teeth, 8 pitch, and where it was keyed to the cutter spindle the spindle was ¾-inch diameter; think of the massive proportions, and we wanted to cut up to 4-pitch cast iron and 5-pitch steel rack with the thing.

We cut a few cast-iron blanks, 1⅞-inches face, 4 pitch, first stocking them out with a narrow milling cutter. It took *fifteen minutes per tooth* to stock them out and ditto to finish, or a total of *half an hour a tooth*, so it didn't take us long to decide that this method should follow its predecessors.

Our next effort resulted in the attachment shown herewith, which, so far as I know, is unique in principle; at least in its application to a miller, though I believe Warner & Swasey make an automatic rack-cutting machine of this stamp. The cutter is mounted at the end of a long stiff spindle, to which is keyed a spur gear of comparatively large diameter. This gear is driven by a pinion mounted on a shaft which is driven from the main spindle by miter gears. Notice what a stiff, smooth and powerful drive this combination makes compared with the ordinary rack-cutting attachment with its trappy little gear; and though the design is of necessity clumsy and the length that can be cut is limited, the extra stiffness and power offset the disadvantages.

A stocking and finishing cutter mounted side by side, as shown, can be fed at more than three inches a minute, through a 4-pitch rack blank, so that at last we have a moderately productive rack cutter. When we found out the speed at which the cutter could be fed and what a short space of time it took to run through we also discovered that it seemed to take nearly as long to index the table as it did to make the cut, so we made ratchet gages, one for each pitch, to bolt on to the front of the bottom slide, with a pawl, to mesh therewith, fastened in the slot provided for the automatic-feed knock-off dog; this proved to be a lot quicker and less trying to the nerves than the graduated dial method. We next discovered that the apprentice who had charge of this machine, in his efforts to produce racks which were an exact counterpart in pitch of the master, had jammed the feed-screw handle hard up every time, with the result that he had slightly moved the pawl; so the final step in the evolution of our rack-cutting methods was the provision of a handle with a spring plunger which would slip when the pawl came up against the teeth in the master.

The table is fed outward so that the feed screw and all parts will be in tension.

With this attachment we can cut up to 4-pitch cast iron and 5-pitch steel, and no doubt if the machine itself were as strong as the attachment, 3- or 4-pitch teeth could easily be cut in cast iron and steel respectively.

RACQUET.

M——, England.

An Old Stage-coach Factory

At the beginning of the last century, that is, about 1810, there was a stage-coach factory in operation at Suffolk, Conn., making the old-style thorough-brace stage coach.

This factory turned out most of the coaches for the Boston-Albany and Boston-New York stage-coach lines, and also for many other stage routes. The owner of the house was Comfort Lane, who came of old Puritan stock, and it is interesting to note how many of the same family have since taken important parts in the development of our modern shop practice. Mr. Lane was quite an inventor, and manufactured many devices besides the coaches and wagons usually turned out in such an establishment.

The stage-coach factory a century ago was radically different from any manufacturing concern of modern times. The old apprenticeship system was then in vogue, and this particular factory was operated somewhat as follows.

Upon the main road between Springfield and Hartford, there was a group of wooden buildings comprising the wood-working shop, paint shop, and blacksmith shop, in which the various parts of the coaches were fabricated, and in which the finished product was erected.

The stage coaches of those remote days had no springs, but the coach body was swung on a pair of very heavy leather

straps, after the manner of the Concord coaches, which became so famous in the stage-coach days of our Western plains. In addition to the leather straps for supporting the body of the coach, there was always a large leather "boot" at the back, in which the baggage of the passengers was packed. This made it necessary for the stage-coach maker to have considerable leather at his disposal, and frequently the leather was tanned on the premises. The coach builder had to be a worker in wood, leather and iron as well as a painter and glazier. It is of interest to note that the putty used for glazing the coach windows was made by hand in the works.

The working force consisted of journeymen and apprentices in approximately equal ratio. The apprentices were indentured for seven years, usually, and made their home with their employer.

In this case the old homestead which sheltered all these people stood a short distance from the factory, on the same piece of ground. To house and feed all the apprentices, together with some of the journeymen, was quite a problem, and necessitated the operation of a farm and a shad fishery.

The year's supply of meat consisted almost wholly of salt shad and salt pork. The apprentice had to alternate between working in the factory or shop and working at the fishery or on the farm. The hours of work were always long, usually at least twelve hours per day.

While these facts concerning this manufacturing concern are of interest, some of the equipment of the shop and a few of the products turned out are of even greater interest to modern machine-tool builders. The owner was a versatile Yankee, and believed in avoiding as much manual labor as possible, so that the shop was fitted with many fixtures which would now be called jigs. So far as is known, the first pleasure carriages fitted with elliptical springs were made in this shop and shipped to Washington, D. C. The first one was a very modest carryall, and the springs were made of tough second-growth hickory. Their success was so great that they were afterward copied in steel.

The cotton industry was being developed, and Mr. Lane took out a patent on a cotton gin, in connection with which he made a number of trips to the South. This gin consisted essentially of a series of slots between vertical plates, and a series of hooks which were driven through the slots with a swinging motion, so as to draw the cotton off from the cotton seed. The hooks were operated by a cam shaft. It will readily be seen that this machine included a large number of duplicate parts, and to get them out exactly alike, a drop hammer and set of punches was rigged out for stamping out the hooks from sheet metal, and also for punching the holes in them. There were also jigs or rather templets or patterns made for laying out the different parts of the work, so that the pieces were interchangeable.

Unfortunately, Mr. Lane met with an accident in the year 1828, and died while still a comparatively young man, so that he left a large family of growing boys and girls. There were none of the sons old enough to take up the business, and no one else in the vicinity who would take it up, so the working force became scattered and the old shop buildings gradually fell into decay, and all that remains to mark the site today is a pile of ashes, slag, and rusty scrap iron, where the smith shop once stood. It is probable, however, that many of the workmen trained in that old-time factory were leaders in the rapid development which took place in manufacturing lines in New England during the next fifty years. H. M. L.

Two Boring Fixtures

Fig. 1 shows a rather novel drilling and boring jig, with the work to be operated upon shown in dotted outline.

The hole at *A* at the right-hand end is first drilled by letting the jig overlap; the box-shaped casing *B* is next put on, and with the aid of a special boring bar which has a Morse taper hole at one end, a spline to drive pinion *C* and a slot *D* for receiving cutters to bore hole *E*, the latter and hole *F* are bored together. Pinion *C* drives gear *G*, which is feathered to the small spindle *H;* this spindle is used for drilling hole *I*, the feed being by means of hand wheel and screw.

The jig was required to maintain a correct alinement of holes *A*, *E* and *F*, and an accurate center distance between *E* and *I*.

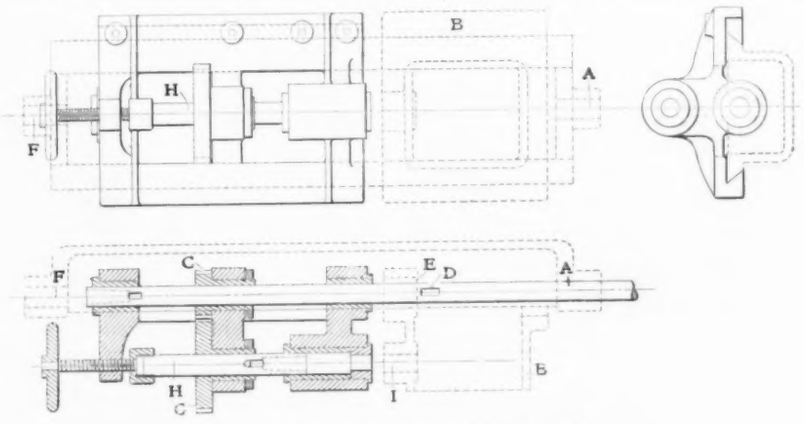


FIG. 1. A DRILLING AND BORING FIXTURE

Fig. 2 illustrates a fixture designed for boring special columns in the lathe.

Our horizontal boring machine would not admit work of this size, so this rig was designed to fit onto our largest lathe, the distance *J* being made equal to the length of the carriage, and slips *K K* provided to allow of easy lifting on and off the lathe bed.

The surfaces *L L*, which are inclined at 45 degrees, are accurately in line with the centers. They are made so that the largest column will rest therein, with its center coincident with the lathe centers; packings are used for smaller diameters of work, the ledges *M* being provided as a stop for these.

The surfaces *N N* are for short columns of larger diameter. They were not designed for any specific job; simply put there for any use that might suggest itself,

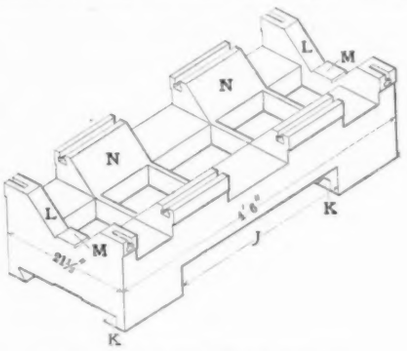


FIG. 2. COLUMN BORING FIXTURE

thus possibly increasing the capacity of the fixture without in any way detracting from its usefulness.

It was intended to use a 4-inch boring bar. This fixture, however, has never been in actual use as, owing to changes in the design of the columns, we have been able to bore them by a different method. It may be useful to some reader who has similar work to do with only a limited equipment of machine tools. RACQUET.

The Tallest Human Structure

The item at page 432 is incorrect. The Washington Monument is *not* "at present the tallest human structure in the world." Its 550 feet of hight sink into insignificance when compared with the Eiffel Tower 1000 ft. high. O. SANGSTAD.

A Boy's Objections to Serving an Apprenticeship

The men were talking about the article at page 158, "A Boy's Objection to Learning the Machinist's Trade," when the Cheerful Idiot said: "I wouldn't for the world have my mother know that I am a

machinist. It would break her heart. She thinks I am a bank robber." The whistle just then blew, or the C. I. would have been mobbed. W. A. BRIGHT.

Effect of Salt Water on Copper Pipes

In many of the large steamships and all naval vessels, pipes of copper are used for fire service, washing decks and flushing toilet spaces. Various means have been tried to stop the pitting and eating away of the pipes, caused by salt water. Composition boxes so made that they can contain a piece of zinc, over or through which the water flows, have been found to be the most effective means of preventing this destructive action. The table, Fig. 2, gives the dimensions for boxes for different sized pipes. Fig. 1 shows the method employed in small pipes or where

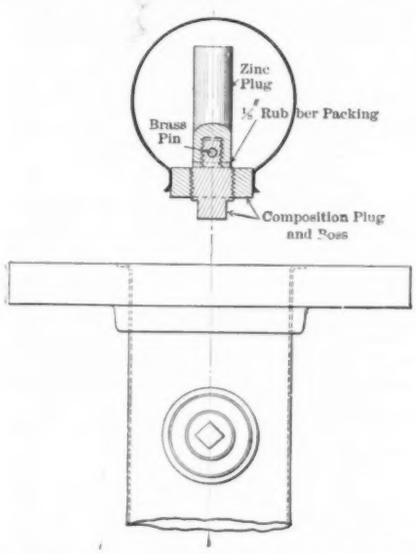


FIG. 1. METHOD EMPLOYED IN SMALL PIPES

the expense of fitting protection boxes would not be justified.

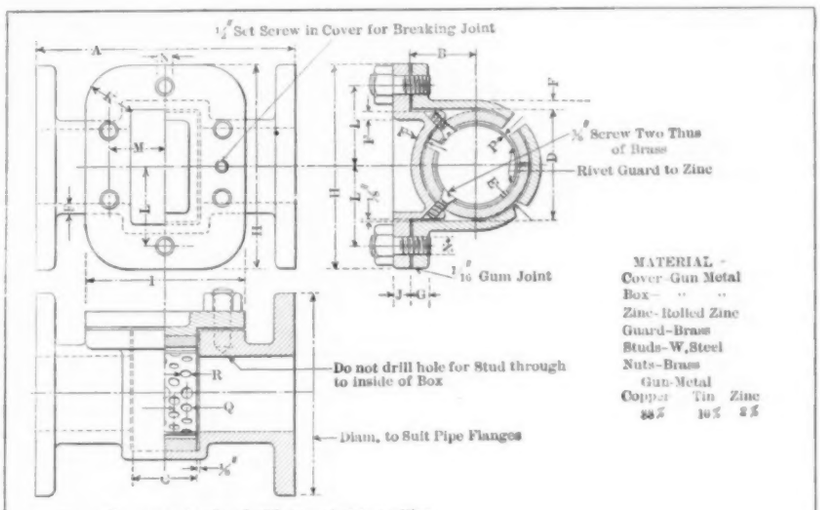
This galvanic action sometimes takes place in unlooked for places. In a recent line of piping which was examined the pipe had been but little affected, and the zinc gave very little evidence of any action; but the Tobin bronze spindles of the valves, which were of composition copper 88, tin 10, zinc 2, were all more or less affected. They were removed and new ones of 88-10-2 were fitted.

A. H. NOURSE.

Doing Worthless Work

This subject has been very engrossing to me since the publication of the first article. I have learned much from it, and it has caused me to take closer notice of what comes under my observation in a like line in the shop where I am employed. Mr. Douglass has broadened the subject in his article, and has made some suggestions that ought to work well in practice. They doubtless do, and I am hoping to hear a further report from Pessimist as to the success of his trial.

There will always be a difference of opinion as to what constitutes "worthless work" between the management of a shop and the stockholders who do not have a practical knowledge of the development of a machine or industry. This has been very clearly shown by Pessimist in his article, and the reply he was tempted to make would have been to the point. He doubtless refrained because it was a little too much so. Such differences of opinion very often arise in the shop between the foremen and their superiors, to the detriment of the company, because the superiors do not investigate such suggestions as are made to them. Of course they should, and are generally given credit for so doing; but *all* of them don't investigate. A few years ago I was placed in charge of the machines in a shop, while the regular foreman was away on a vacation. In the course of the work was a planer job that would not pass between the housings, and an extension had been made to suit the case by placing it between the head and cross rail. This had been made in the form of a cylinder, to secure the necessary stiffness with light weight. Most of the planing to be done was with the down feed, but there had been no connection made between the head and the vertical-feed shaft in the cross rail, so the planer hand had to feed by hand, and the job took about forty hours ordinarily. When I saw the man feeding by hand, I asked where the power feed was, and he told me he had none, nor had been able to get one, as the general foreman would not have it made. As it happened, the general foreman was away that afternoon, and I got the tool-room man over at once and showed him what I wanted. It cost about $2 to make the connection to power feed.



NOTE: Boxes may be placed with cover in any position

Diam. Pipe	Face to Face	Center to Cover Face	ZINC Width	ZINC Diam.	ZINC Thick's.	Thick Metal for Body	COVER Thick's Flange	COVER Length	COVER Width	COVER Thick	COVER Radii. of Corner	STUDS FOR COVER PITCH Length	STUDS FOR COVER PITCH Width	STUDS FOR COVER Diam.	STUDS FOR COVER No. of Studs	GUARD Thick B.W.G.	GUARD HOLES Pitch	GUARD HOLES Diam.
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
2½	8½	2⅛	2	3¾	½	¼	⅝	6¾	5¼	7/16	1½	2⅜	1⅞	⅝	6	#14	½	⅝
3	9¼	2½	2	4¼	½	5/16	¾	7⅞	5¾	½	1¾	3	2	¾	6	#14	½	⅝
3½	9¼	2¾	2	4¾	½	5/16	¾	8¼	5¾	½	1¾	3¼	2	¾	8	#14	½	⅝
4	10¼	3	3	5½	½	⅜	¾	9	6¾	½	1¾	3⅝	2½	¾	8	#11	½	⅝
4½	10⅝	3¼	3	6	½	⅜	¾	9½	6¾	½	1¾	3⅝	2½	¾	8	#11	½	⅝
5	10⅝	3½	3	6½	½	⅜	¾	10	6¾	½	1¾	4⅛	2½	¾	8	#11	½	⅝
5½	10⅝	3¾	3	7	½	⅜	¾	10½	6¾	½	1¾	4¾	2½	¾	10	#11	½	⅝
6	10⅝	4	3	7½	½	5/16	¾	11	6¾	⅝	2	4⅝	2½	¾	10	#11	½	⅝
6½	10⅝	4¼	3	8	½	7/16	¾	11½	6¾	⅝	2	4⅞	2½	¾	10	#11	½	⅝
7	10⅝	4½	3	8½	½	7/16	¾	12	6¾	⅝	2	5⅛	2½	¾	10	#11	½	⅝
7½	10⅝	5	3	9	½	7/16	¾	12½	6¾	⅝	2	5⅜	2½	¾	10	#11	½	¾
8	10⅝	5¼	3	9½	½	½	¾	13	6¾	⅝	1½	5⅝	2½	¾	12	#11	½	⅝
8½	10⅝	5½	3	10	½	½	¾	13½	6¾	⅝	1½	5⅞	2½	¾	12	#11	½	⅝

FIG. 2. DIMENSIONS OF BOXES FOR DIFFERENT SIZED PIPES

The planer hand said he saved about ten hours on the job, and yet the general foreman would not take the time to consider the suggestion. Some time after the regular machine foreman returned, there was a similar job. I saw the general foreman eyeing the power feed, and as he was also making some inquiry concerning it from the planer hand, I thought I would "catch it;" but he pronounced it O.K., so I was told. This kind of thing is risky, unless you are positive of your results, and is not to be indulged in too often even then, if you value your position.

About a year ago we began to improve a shop tool, and a plan was submitted by the shop superintendent (who invites our opinions on most things) with instructions to make one. Our opinions being asked, we endeavored to show him how the same result could be attained with the same number of parts as already comprised the tool, without the addition he was offering. He was of the "same opinion still," and the addition was made, and it worked satisfactorily—to him—but not to me. I made the tool as I had tried to show him it ought to be made, and had it tried alongside his design, on the sly. There was a saving of about 75 per cent. in time in favor of my design. The man who made the trial told the superintendent without my knowledge, and also made a trial for him to see. In a few days he came round and ordered all similar tools made like the one he turned down at first. A few days ago I left a drawer open, in which were a couple of tools of his design, and on his seeing them he said: "I guess you had better get them out of the way, as we are past that now."

In any shop that tries to better the way of doing things, some of the efforts will be worthless, if you take an inventory at a certain time; but I believe in most cases there is a financial, as well as visible improvement. A great trouble in this respect is the attempt to do too many things, only about one-half of which are ever completed. This is where the "grand vizier" can get in his best licks by having all proposed improvements sent to him, with estimates, and those that are passed made as soon as conditions will permit. I can go through the shop where I am employed, and find many jobs that would have to be entered among the losing class; but, on the whole, there is a big account in favor of profit.

I was building a machine once, and in its construction some three dozen fillister screws were needed. We had the proper size on hand, but I was instructed to fix up a hollow mill we had, suitable for the job, so that a boy could turn them out for us. They were made of a bad quality of iron, too, and cost not less than 5 cents apiece. The excuse for this job was, "We want to make every part of the machine here." The sentiment was all right, but I am learning that sentiment doesn't count for much in a machine shop, unless it is a money maker, and believe others are destined to learn the same.

I believe it a good plan to require estimates with all proposals, as it will benefit the one making it; and also to give the man an opportunity to state his reasons for offering it, as he may have some special knowledge that one can't get otherwise, that would help one to see a need, and also remedy it.

We all have our limitations, and to secure a minimum output of "worthless work," *take* time to look over shop suggestions and *see* that shop work gets the attention it deserves—the very best, as that is what the stockholders are looking to for dividends, and you for your salary.

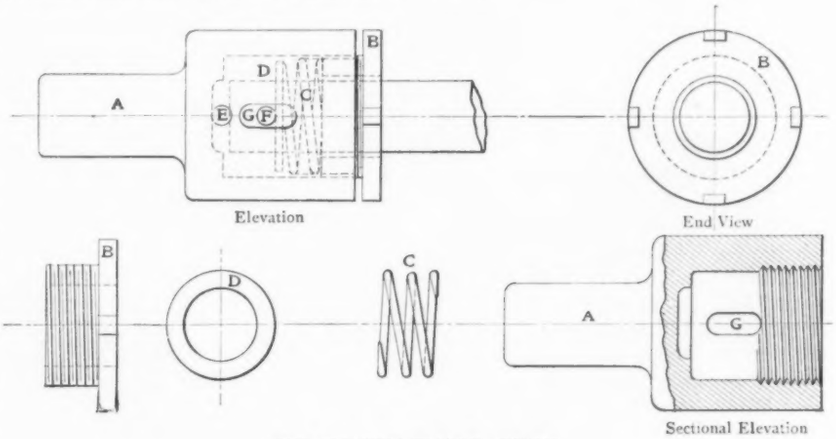
E. T. Strong.

A Floating Reamer Holder for the Turret Lathe

The reamer holder here described is not expensive to make. It is constructed so as to allow the reamer to float parallel with the hole and not pivoted from a fixed point. We have got very good results from its use over an extended period. *A* is a mild-steel socket, the reduced end of which fits in the turret holes, the large end bored as shown in the sectional elevation. The front part of the hole is threaded to receive the threaded adjusting sleeve *B*, bored ⅛ inch larger than the diameter of the reamer shank. *C* is a spring made of 10 B.w.g. steel wire. It is forced up against the washer *D*, by the adjusting sleeve *B*. *D* in turn presses up against the driving pin *F*, ⅜ inch diameter, which passes through the shank of the reamer near the end as shown. It extends through the slot *G*, ½ inch wide x 1 inch long, milled in each side of *A*, and prevents the reamer from turning. *G* is an ordinary ¼-inch hard-steel ball which rests in the center hole of the reamer and the recess cut in the back of *A*. There being very little friction it rolls to the path of the reamer and allows it to find its own center under the pressure of the spring *C*. The slots milled in *B* are for a spanner.

J. Green.

England.

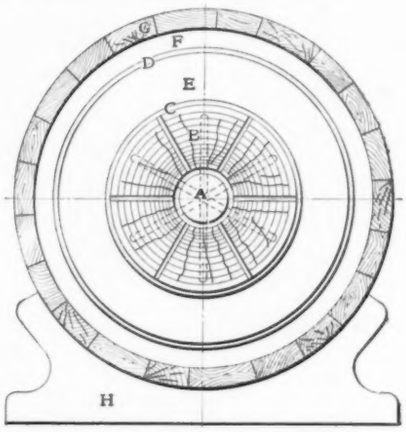


THE FLOATING REAMER HOLDER

What Became of the Sleepy Eye Engine? — Another Defunct Fake

In conversation with a number of mechanics a short time ago, someone asked what became of the famous Sleepy Eye engine. No one could tell.

I thought perhaps some of the readers of the American Machinist could.



SECTIONAL VIEW OF THE ST. JOSEPH FRICTION HEATER

Also that they would be interested in knowing what the St. Joseph friction heater exploited in daily and other papers all over the country two years ago, really was and what became of it.

The American Machinist commented on it editorially at the time and this I believe was the only adverse criticism published.

It was invented by a negro named Baker at St. Joseph, Mo., in 1903, or earlier, as the first I knew of it was in the winter of 1903-4.

I was in charge of a small machine shop there at that time and was commissioned by a firm of promoters to build the first machine. They were very secret about their object at first and would only allow me to make one piece at a time.

After I was so far along that I could see what they were driving at, they let me into their great secret.

Here was a poor colored man who had

discovered a way to utilize one of the great forces of nature, and would, with his invention revolutionize the heating of homes, cars, etc.

A glance at the sketch accompanying will show how the machine was constructed.

A is a shaft 1½ inches diameter; *B*, hardwood segments working loosely on pins driven through shaft; *C*, brass tube ¼ inch thick, 6 inches diameter; *D*, 12-inch iron pipe; *E*, water space; *F*, mineral wool; *G*, wood lagging; *H*, cast-iron base.

It was 36 inches long and had cast-iron water-tight heads closing the ends and carrying bearings for the shaft *A*.

A pulley on the end of the shaft completed the thing except piping from the water space *E*, to the radiator and return. When the shaft was rotated the segments would of course fly out against brass tube *C*, and cause friction.

At a speed of 600 revolutions per minute it would generate enough steam in about an hour's run to run one of these little engines on a peanut roaster for three consecutive minutes.

I do not know how it got such wide publicity or so much free advertising. One of the leading daily papers of the country devoted a full page to it. I do know, however, there were quite a number of men, well up in affairs in general, who were interested financially and otherwise. This I attribute to ignorance in regard to things mechanical of men in general.

The AMERICAN MACHINIST's criticisms should have warned anyone to keep hands off, but the class of men who invest in such things do not know there is such a publication.

After several lawsuits, injunctions, etc., it finally passed into the hands of some St. Louis parties who tried to make a go of it, but of course, failed.

In November, 1904, it passed to its last resting place in the basement of one of the large office buildings among the rest of the junk. KIOWA.

A 14-Inch Adjustable Boring Head and an Expanding Reamer

Fig. 1 shows the construction of a 14-inch adjustable boring head with 10 high-speed steel cutters ⅝ inch square.

Fig. 2 shows an expanding reamer of the same diameter, with high-speed steel blades. Both tools are adjusted by means of a taper nut and ½-inch tool-steel pins. The cutters in the boring head are held in position by ½-inch set screws, and the reamer blades are held by taper pins.

C. W. PUTNAM.

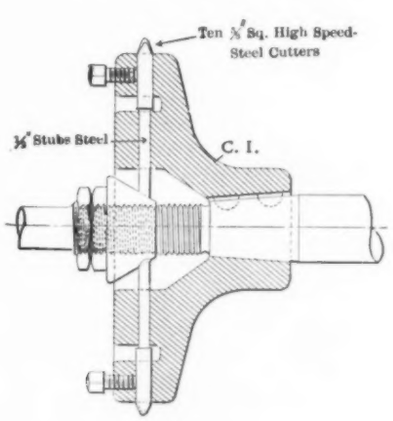


FIG. 1

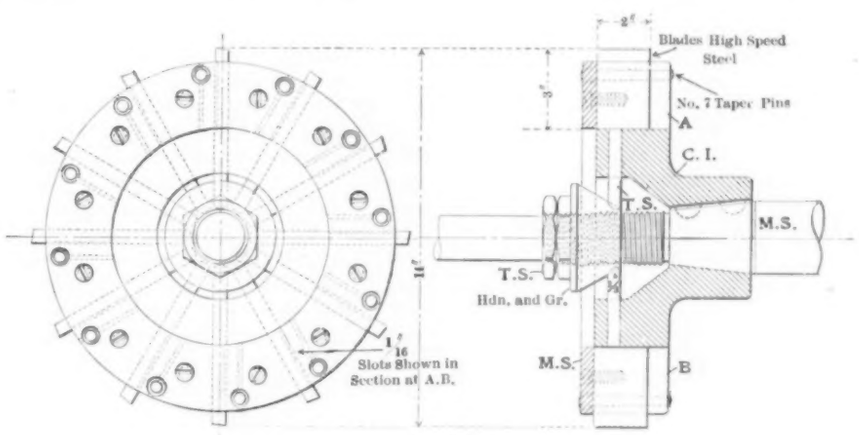


FIG. 2

14-INCH ADJUSTABLE BORING HEAD AND EXPANDING REAMER

Starting a Shop—Cash or Credit

My experience in starting in business may be a help to others. All of you who are old enough will no doubt remember that 1893 was a very bad year. Work was scarce and jobs few and far between. I had quite a number of jobs which lasted from a few days to a few weeks each. These varied from marine to textile work with occasional jobs at tool making. At last the variety of it all palled on me and one evening, on my return home after an unsuccessful search for work which had lasted for nearly a week, I came to the conclusion that there must be some relief for a man so eagerly in quest of work as I. Suddenly the bright inspiration struck me: Why not start a shop of my own? I had nothing to lose but time and *my* time seemed to be a drug on the market. So I talked the thing over with my wife and she, woman-like, had unlimited belief in me and gave me her encouragement.

What I did subsequently I do not think would be possible in any other country than the United States.

I was absolutely unknown. I had no relations or friends with influence on this side of the ocean.

The next day I called at a machinery supply house in Philadelphia, told the manager I wanted a 16-inch Hendey lathe; a 12-inch 4-jaw independent chuck; a large drill chuck for the tail spindle; a 16-inch drill press; a small boiler and engine, and a few small tools.

The whole outfit amounted to nearly $500. I told him I could only give him the men for whom I had worked as references, and that I could give him a small deposit only, say $30, as I wanted to keep as much cash in hand as possible.

He was to look up my references and if they gave a good report of me I was to get the tools on paying the $30 deposit, the balance to be paid in instalments of $10 a month or as much more as I could afford.

I was living in Camden, N. J., at the time and made the mistake of starting business in that town instead of in Philadelphia. I did this because rents were low and I did not at time know that the rent a man pays is of no consequence so long as the business is there.

The next day after seeing the machinery dealer, what was my surprise to see a team pull up to the door with the tools I wanted. They had been shipped out of one State into another, I had not signed an agreement, chattel mortgage or any other paper, and had not had a chance to even pay the $30 deposit. You will probably think as I did that this was rather a loose way of doing business. I found afterward that my references had not been questioned either. To quote the man who sold the tools, "I thought I would take a chance on you." The chance and I paid him. He got his money; sometimes only $10 a month and once I find I paid him $75. That was while I was building the first perpetual motion I built in my own shop. To the man starting a shop I offer the following advice: Keep as much cash in hand as you can. It's not good either for yourself or the work to have to rush it through so as to get sufficient money to buy your next meal.

Always pay cash for supplies if you can. If you can't, meet your bills promptly, even if you have to make arrangements *at the time you buy the goods* for a credit longer than usual.

Give your customers the quality of work

and material you agree to give them. Treat them *square* as long as they treat you that way.

Give as few credits as possible. If you go about it in the right way you will have very few bad debts. Get a good plain sign, large black letters on a white ground, "A deposit of 50 per cent. is required on all work," and put it up in a conspicuous place in your office if you have one (I hadn't) or at your desk. *And stick to it.*

To people you know, you can explain that you can't afford to give credit, to others the 50 per cent. is your rule. I have found that the average American is very considerate to the man starting in business. It is so often the case that, but a few years previously they have been through the mill themselves; this I think engenders that "fellow feeling," which "makes us wondrous kind."

It takes a long time to build up a connection. I will not dwell on the struggle I had. I came out on top in the end, but it took a long time to learn the axioms I have put down here.

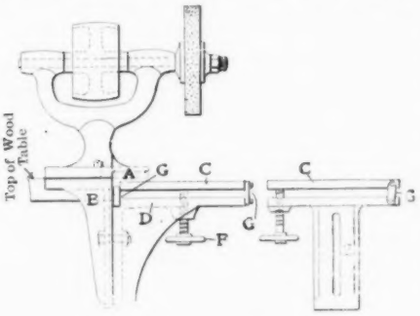
If you are in a place where gas is obtainable never buy a steam engine and boiler. A gas or gasolene engine needs little attention and costs considerably less than a *small* steam engine to run. Of course, where a man can rent power at a reasonable rate it is still better. As regards the retaining of men you have hired don't let goodness of heart compel you to retain a man that's "no good." Treat him fairly and let him know he is not suitable so he can have a chance to look out for something else.

I never had any difficulty if I wanted them, in getting men again who had once worked for me. All I had to say was, "Billy, I have a job for you but let Jones have a week's notice from next pay day," and Billy would show up at the appointed time.

DIXIE.

A Cheap Surface Grinder

I have a number of plain, flat dies that are worked very hard, and require frequent grinding. Not wanting to put any money into a new surface grinder, I rigged up a grinder as shown in the sketch herewith. The patterns cost little, and there is not much machine work, yet the grinder does the work perfectly. Since making my first grinder I have built seven, which have paid for the first cost twice over.



A CHEAP SURFACE GRINDER

The wheel stand is one of the ordinary kind that can be purchased at any supply store. The base is planed at the bottom, and the part indicated by dot and dash lines at *A* is cut off. *B* is an angle iron bolted to the wheel frame; *C* is a plain, flat plate, hinged at one end; and *D* is an angle iron which has a vertical movement, and is secured to *B* with a bolt in slot *E*. The screw and hand wheel at *F* give a fine vertical adjustment to table *C*. *G G* are plain, flat iron hinges. The die or piece to be ground is placed on the table, then *D* is set about right, so that the work will touch the wheel; then the work is moved back and forth under the wheel, and the required feed given by hand wheel *F*.

GRINDER.

Worthless Work

Just what constitutes worthless work will probably always remain an open question and depends, perhaps, somewhat on the definition of "worthless," and one's point of view. A device that when finished is worthless in itself may have value in that it shows what can not be done, yet if all parties concerned knew beforehand that it would not work, then it is certainly worthless. Again, a completed device that is useful may have considerable useless, i.e., worthless work upon it. Generally speaking, worthless work may be defined as work that serves no useful purpose, as for instance, polish on the face of a wagon tire or finishing the outside of a water main, or the inside of a locomotive firebox.

An experience of my younger days comes as near to the definition of worthless work as I can think of at this time.

We had a hose fixed up to keep a small stream of water on the main bearing of the factory engine. In some way this became displaced during my absence from the engine room, and fell so as to direct the stream of water in between the main belt and fly-wheel. As the belt was heavily loaded, the water caused it to slip on the main driving pulley, and the machinery of the factory came to a sudden stop. The engine, however, was working quite as hard, if not harder, than usual. This whole plant, as it afterward developed, was engaged at the time in doing worthless work, as its entire product for months proved to be worthless, and had to be thrown away. In this case, so far as I know, the failure of the goods did not aid in making a later success.

The sliding of the belt represents a kind of worthless work that is very widely done. Taken literally, the sliding of slack or insufficient belts which goes on continually, and everywhere, in shop and factory, represents an enormous loss, and obviously a loss which is largely preventable.

The idea widened out takes in lack of good management or attention to good business methods, poor methods of doing work, inadequate machinery, bad location, lack of sufficient room, or lack of capital, etc. There are few shops probably that are not handicapped by some of these difficulties. Now I take it that in business, success will depend very largely upon the amount of worthless work that one does.

In the nature of things everyone will do a certain amount of it in a lifetime, but it hardly need be said that the less worthless work a man or a shop does the more likely he or it is to succeed. The ability to see the worthless work beforehand and avoid it is what constitutes good management or good business judgment.

The correction of the belt-sliding phase of worthless work in a shop or factory having an established business is a comparatively simple matter. A disposition to make the correction, and a careful study of conditions will usually eliminate the trouble to a great degree, if not entirely. Just as putting a belt in good condition will enable it to do its full share of work. But when it comes to the second phase that I have suggested, by failure of the factory to make good goods, i.e., the establishing of a business, the elimination of worthless work becomes a very serious problem. It is here in fact, that a great deal of what would appear to many as worthless work must needs be done, and the man who spends time and money to prove in a small way, if it may be so done, that he can or can not do a certain thing will spend the time and money to good advantage.

Time is usually a very important element. It may try the patience, but as nothing may safely be taken for granted, it will always pay to wait until every detail of the situation can be carefully studied.

To the proprietor of the small jobbing machine shop, the question of doing or not doing worthless work is a very serious one, and while he will rarely be called upon to refuse the shady job of the gambler or burglar for which he might get big pay, yet he will certainly have plenty of chances to do jobs for which he will receive no pay at all. I take it that no matter how useful or useless the work may be to someone else when finished, so far as he is concerned it is worthless to the shop proprietor unless he is paid for it. This may refer to work done by regular shop methods, and lost by reason of the failure of the customer to pay his just debts. For instance the perpetual-motion crank who is willing to go down into his pocket and fish up the cash in advance to pay you for demonstrating that his pet theory won't work is rather a rare bird according to my experience, and the one that will pay when he finds that he is mistaken is still more rare. He is usually willing to let you do

the experimenting on your own account it you are green enough, and then when he sees failure, he quietly fades away. This applies to a large class of inventors as I know them. The amount of worthless work the shop man does for the inventor man is almost unlimited. And the worthless work that the inventors of the world do is not easily measurable, but enormous in amount. I do not refer here to necessary experimental work, for there are very few inventions that do not require a certain amount of what may be called proof work, which while we may throw it away, is just as necessary as the scaffold is in the erection of a building, but I mean the inventing of useless things and the reinvention through ignorance of old and sometimes obsolete devices. Possibly though I am wrong in calling this worthless work, for to invent requires thought and as thoughts beget thoughts perhaps this seemingly useless inventing serves a good purpose in the end.

Then the shop proprietor may do lots of worthless work in getting up special rigs to do odd, big or hurry jobs, for handling which the shop has no adequate facilities. The job shop proprietor will usually take every legitimate job offered to him, and provide the facilities afterward. These special rigs always cost a great deal more to get up than was expected at the start; they very often fail to come up to expectations in doing the work, and it is seldom indeed that enough can be got out of the job to pay for the special tools that have to be made to do it.

Circumstances alter cases, of course. It is business, and will pay to get up a makeshift rig for a job on which a whole factory may be waiting, and yours the only shop within fifty miles; but quite another thing to tackle a similar job when you are within a block or two of a shop equipped to do the work in a half or a third of the time in which you are able to do it. In the former case you would probably have no difficulty in getting paid for all the work you do, while in the latter you will perhaps not only not get paid for your work and trouble, but lose your customer into the bargain. I am often filled with admiration for the ingenious rigs described in your paper for doing special jobs, and with wonder, too, when I read how quickly some of them operate; but while many of these schemes are legitimate and fit the case in hand, yet many times they are apt to require lots more time and bother than seems to be warranted.

Just how far to go in the matter of special rigs is a nice question. It calls for the finest judgment, and I think perhaps is easier to handle in a small shop when the proprietor is himself able to decide the question, with a full view of all the conditions involved than it is in the large institutions where, perhaps, one man knows all the conditions. The large shop can lose a lot of money trying to get along without proper appliances for doing its work, just as it can as easily lose it by having every Tom, Dick or Harry fix up temporary and useless rigs to save themselves a little extra effort.

This latter should not be allowed anywhere, without first having the matter passed upon by some one or more men possessed of the requisite knowledge and judgment to decide what shall be done in the premises.

This leads me to the question of shop system, or lack of it, as a means of accomplishing worthless work. Here again is a matter that calls for careful judgment, based upon knowledge of all conditions. While a shop may do worthless work by reason of a lack of system, yet it may accomplish much more of it by having too much system. It is very nice to know, down to a fraction of a cent, just what every piece or job costs when it is finished; but if it eats up all the profit on the job to find out how much it costs, it is quite as well, perhaps, to make a stalwart guess at the cost in the first place, and let it go at that.

Much worthless work may be done by installing the premium system, for instance in a shop, when under the conditions imposed it is a foregone conclusion that no one will attempt to earn any of the premiums. I do not want to be understood as belittling either a good cost-keeping system, the premium system or any shop system, but simply wish to point out that while a system should be adequate for the daily needs of the shop, it should be no more than this, and should be installed just as a standard type of machine or tool is, that may be used every day in the year, rather than a freak machine that will stand idle eleven months out of the twelve.

W. L. HARDY.

The ever present subject of deficient postage on foreign mail matter is again discussed in the *Daily Consular and Trade Reports,* and various consuls give instances illustrative of their experience which must have been especially exasperating. Consul A. Gaulin, of Havre, calls attention to the fact that many leading English houses avoid this trouble by using a special envelope which is marked "Foreign Post," such envelope calling the attention of those who do the mailing to the fact that ordinary domestic postage will not do. This is a plan which we ourselves proposed many years ago and which seems to work well wherever tried.

The gas engine is notable for its economy, nevertheless a good deal of heat is wasted in the exhaust. At Kilmarnock, Great Britain, raising steam from the exhaust gases has been successfully tried, the hot gases from a number of gas engines driving dynamos being passed through boilers.

Production of electrolytic copper for 1906, probably about 800,000,000 pounds, worth about $150,000,000.

Instruction by Correspondence—The International Correspondence Schools; Something of their Origin and the Methods of their Management*

On the occasion of the first formal celebration of an anniversary of an educational institution conducted on new principles, it is fitting that the plan through which its success has been attained should be officially stated. This task devolves on me by reason of my position at the head of the institution.

FIRST FOR THE INSTRUCTION OF MINERS

The schools had their beginning in efforts to teach coal miners to qualify for the examinations that candidates for appointment as mine inspectors and mine foremen must pass in this and other States. To pass these examinations, they must solve the formulas governing the flow of air through mine passages and understand the gases met with in mines, mine surveying, and the machinery used about mines. To do this, they need to know many of the processes in arithmetic, including involution, evolution, ratio and proportion; the use of the signs and symbols employed in formulas, the application of formulas and their solution, and something of chemistry, geometry, trigonometry, mechanics and hydromechanics. It is no ordinary educational problem to impart this knowledge to men who never attended school, or did so for only a year or two before they were put to work; who are ignorant of the first processes of arithmetic, whose average age is 27; who work every day in the mines; who have families to support; who cannot quit work to attend a day school; and who will not attend night school because they cannot be present at every session and because they are ashamed to expose their ignorance to others who attend; who, when studying at home, use the kitchen table for a desk, and often rock the cradle with one hand to keep the baby quiet, while holding their lesson paper in the other—it is no ordinary educational problem, we say, to impart this knowledge to such men. The present I. C. S. plan of teaching is the perfected system with which men conditioned and situated as described are qualified in all the subjects of a mining education, and made mining engineers, mine inspectors, mine superintendents, and mine foremen.

OTHERS TAUGHT

In perfecting the system to teach mining, we learned that we could teach all the engineering trades and professions. The first contracts provided that the min-

*Paper read by President Thomas J. Foster at the exercises in connection with the celebration of the fifteenth anniversary of the schools, October 16, 1906, at the Lyceum theater, Scranton, Penn.

ers should come to Scranton to learn surveying and mapping in day classes under the instruction of present teachers. We did not know that we could teach the use of surveying instruments or drawing by mail. But the students could not spare the time nor afford the expense to attend classes at Scranton. We were compelled to experiment, and were successful in making a textbook from which the student could learn, without the assistance of a present teacher, to use a surveying instrument and make a map. A few years later, we were teaching mechanical and architectural drawing to thousands. We have enrolled to date over 100,000 students in drawing courses, the drawing is part of the instruction in all the engineering courses. We have over 8,000 students in art courses, in which are taught, among other subjects, free-hand drawing, perspective drawing, pen-and-ink rendering, water-color rendering, drawing from nature, drawing from casts, and drawing from the human figure.

An idea of the present scope of the instruction work may be obtained from the thirty-one schools into which the teaching organization is divided. Each of these is in charge of a principal, who may have an assistant principal, and will have in his separate organization from one-half dozen to over fifty examiners and assistant instructors.

The titles of the thirty-one schools are: Advertising, Architecture, Arts and Crafts, Chemistry, Civil Engineering, Civil Service, Commerce, Drawing, Electrical Engineering, Electrotherapeutics, English Branches, French, German, Spanish, Law, Lettering and Sign Painting, Locomotive Running, Mathematics and Mechanics, Mechanical Engineering, Coal Mining, Metal Mining, Navigation, Pedagogy, Plumbing, Heating and Ventilation, Sheet-Metal Work, Shop and Foundry Practice, Steam and Marine Engineering, Structural Engineering, Telephone and Telegraph Engineering, Textiles, Window Trimming and Mercantile Decoration.

SPECIALIZATION

One of the most important features of I. C. S. instruction is specialization. We teach workers who must take for study, time which would otherwise be given to recreation and rest. They study under so many disadvantages that their instruction must be restricted to the processes and principles of the particular trade or part of a trade in which they desire to be educated. Therefore, the instruction is grouped into many courses, to suit the requirements of the students. Thus, there are stationary engineers who wish to qualify to care for and operate a small steam plant; others, who want to qualify to take charge of a plant of 250 horsepower, and others again who want to qualify to superintend a plant of thousands of horse-power. We have, therefore, three steam-engineering courses. In the advanced courses, the subjects are treated at greater length, and instruction in more subjects is included. The School of Electricity teaches thirteen courses; the School of Mechanics, ten, and so on.

POINTS OF DIFFERENCE

The plan of the schools differs from the methods usually employed in teaching, in the following particulars:

First—The textbooks used are prepared specially for home study.

Second—The work of the student is corrected, and he is directed and assisted in his studies, through the mails.

Third—The courses of instruction are sold on the monthly instalment plan, through publicity and solicitation, to persons, the majority of whom before they are approached by representatives of the institution, have not seriously thought of self-improvement. These miners, mechanics, and others, are induced to undertake courses of study by inspiring the desire for technical education and creating the self-confidence necessary to begin the work. Students that become discouraged and quit studying are recanvassed and induced to resume their studies by the representatives as they call on them from month to month for their instalment payments.

Five per cent. or more of the scholarships are sold to men engaged in the engineering trades and professions—some of them graduates of scientific schools, who buy the textbooks for reference purposes, because they are concise, complete, practical and better indexed than other technical publications.

Twenty per cent. are sold to persons who desire to qualify for civil-service examinations or the examinations in mining, steam engineering, electricity, plumbing, etc., required by many States and municipalities, or who are alive to the advantages of technical training and desire to educate themselves to obtain promotion or advancement.

Thus, about 25 per cent. of the business comes through the demand for a practical system of home study in the theory of the trades and engineering professions, but the larger part—75 per cent.—is secured by creating the demand.

INSPIRATIONAL PUBLICITY AND SOLICITATION

You cannot give away education; you can give free instruction. Men will not study unless strongly influenced. Students with whom the desire for improvement is a controlling motive will take full advantage of opportunities for free instruction, but the proportion of the ambitious to the whole number that should study is small. Most of those we enroll will not accept a scholarship as a gift on condition that they are to use it, before their ambition is aroused and their self-confidence stimulated.

Of the great majority who undertake to study, it is true that they need in the start, until the study habit is formed, every aid to perseverance. The more this class pay for tuition, the better, as the fact that they themselves pay the price is an incentive to work.

The greater portion of the I. C. S. courses are sold to careless and indifferent persons, by arousing their ambition, building up their self-confidence, and inducing them to enroll by what I shall call *inspirational publicity* and *inspirational solicitation.*

There are but two ways to sell: first, through publicity, which is *advertising;* and, second, through solicitation, which is *salesmanship.* We employ both. We publish and talk the benefits of education and the great rewards open to men who can do work better than their fellows; that education is the key to the doorway to success; that we have a practical means for men that work to educate themselves in their work at their work; that a man can form the study habit and educate himself; that we have special textbooks, easy to learn, easy to remember, and easy to apply; that the price is within the reach of all since it can be paid at the rate of $5 or $3 per month, and that if, for any reasonable cause, such as sickness, or loss of employment, the student is unable to make his payments promptly, he is given time, and permitted to continue his studies in the interim without additional charge.

ADVERTISING

We advertise in every publication from which we can obtain *prospects* (a name for persons sufficiently interested to make inquiry about the courses of instruction or methods of teaching) at a cost not too great, and are using a hundred mediums, mainly magazines and trade journals. If we had the capital to carry large advertisements in the daily papers for a year or more, we could probably obtain results through them, and also through bill-board and street-car advertising.

The advertising is made effective by illustrations that catch the attention of the indifferent, untrained mechanic, make him realize his unfortunate position, and suggest to him that he can improve his condition by mastering the theory of his trade.

The enrolment is not made from the educated or cultured classes; the only qualification required to enter for a course is the ability to read and write English. The plan is intended for persons ignorant of elementary mathematics who cannot attend a regular school to study, and for whom there has heretofore not been provided a practical means for self-education. We find that drawings, such as, "Are Your Hands Tied," "On Which Side of the Desk Are You," etc., will halt these people as they drift through life, and give them the first suggestion they have ever had, perhaps, that there is something better to which they can attain.

If our advertisements were simple announcements of technical courses to sell, as are the advertisements of the regular schools, we would not have one inquiry where we now have a dozen. It is said that last year if there had been ten graduates from the Massachusetts Institute of Technology for every one that did graduate, they all could have found employment at good salaries. Why not advertise this important truth that young men may be induced to take advantage of the opportunities offered by that great institution and others like it?

One of the greatest needs of the time is some agency to make more of the people desire education sufficiently to deny themselves to obtain it. If Mr. Carnegie will supplement his magnificent gifts for libraries by establishing a foundation to provide half a million dollars annually to be expended in advertising the benefits of education and the resources of his libraries, he will be surprised by the great increase in the number using his libraries.

This *inspirational* advertising in magazine and trade papers, in millions of circulars placed in the homes of the country every month, in exhibits in retail-store windows, and in shops where mechanics are employed, produces prospects. An inquiry received from the advertising is answered by the mail-sales department, and, if the prospect resides in a route, his name and address are forwarded to the representative of the schools who calls upon him, furnishes information required, and solicits him to enroll.

FIELD FORCE

The field organization of the schools consists of 800 routes, grouped in 240 divisions of three or more routes each, which are arranged in 34 districts of seven or more divisions each, and covers the United States and Canada. Twelve hundred salesmen represent the Institution in these routes, divisions and districts.

There is also a railway organization, in charge of a general manager, in which there are employed eighty salesmen. The schools own and operate seven air-brake instruction cars, a dynamometer car, and a passenger-railway service-testing car. There are instructors lecturing on combustion of fuel and firing, on nine cars that are furnished by railroad companies. We are soliciting business on over one hundred railroads in the United States and Canada, to whose employees we sell locomotive-running scholarships at reduced prices, in consideration of facilities for doing the work provided by the company. The first arrangement of this kind was made with the Canadian Pacific Railway eight years ago. That we have been selling on this road ever since, and are doing as large a business now as at any time in the past, is evidence of the excellence of the educational service we give.

The salesmen arouse the ambition of people ignorant of or indifferent to the advantages of technical education; create in them a desire for self-improvement; convince them that they can educate themselves by home study; and induce them to undertake courses of instruction, and afterward encourage them in the cultivation of application, concentration, and the study habit, that they may persevere in their studies.

SALESMEN AND ALUMNI

A salesman can tell more effectively than advertisements the story of the great disadvantages the working man labors under, who is ignorant of arithmetic, drawing, and the theory of his trade, and can speak with more effect of the opportunity offered by the schools to remove these disadvantages. He makes the prospective student dissatisfied with his present condition, and points out the road to better fortune. He can give full particulars, answer objections, and remove doubts. He convinces the prospect by his earnestness, and, if necessary, convinces the wife or father, or mother, or all of them. It is often necessary to do this, because an engagement to pay for a scholarship is an important transaction for many working men, and other members of the family must sometimes be consulted. Most of the students obtained from advertising prospects are enrolled by salesmen. The advertisement secures the interview for the salesman.

The student body created during the past 15 years is as productive a source of prospects and enrolments as is the advertising. The alumni of a college is a valuable asset; and the army of hundreds of thousands of I. C. S. students is a powerful ally in promoting its interests. The student enrolls, makes sufficient progress in his course to derive benefit, and tells his friends. An advertisement is not so effective as the testimony of a student who, through home-study training, has advanced in his trade, or in some other occupation, to a position of responsibility. Seeing is believing. Such testimony creates a desire for improvement in thousands who might otherwise remain indifferent. Every month, hundreds of students are promoted. They know the work and its great value and can intelligently and earnestly urge their fellows to do as they have done.

Many students voluntarily assist the salesmen in enrolling their friends, and all who do assist are paid for the service, if they will accept payment. The students are systematically solicited to aid in the work, on altruistic grounds, and without their assistance the large enrolment required to minimize costs could not be obtained. The same equipment in textbook plates, buildings, printing plant, etc., and the same organization at home and in the field would be required if the enrolment were but five thousand per month.

RESULTS

In considering the educational work being done by the schools, it must be investigated from two points of view: (1) the benefit derived by the individual student; and, (2) the proportion of students benefited.

The booklet which you found in your seats, entitled "Short Extracts from the School Histories of I. C. S. Students," will help in forming an opinion as to the value of the work to the student. If any gentleman desires to inquire further into this subject, we will furnish him with a list of the students living in his own locality whom he can interview. The limits of this paper will only permit me to say that with I. C. S. texts, and help through the mails as given by the I. C. S. instructors, any man can learn to draw and obtain a full knowledge of the theory of any of the trades and professions we teach. To that extent and all it stands for, we can help a man starting without any knowledge of mathematics.

As to the proportion the students helped bear to the whole number of students, it is impossible to give exact figures, but a comparatively correct estimate can be made.

As previously stated, most of the scholarships are sold on the instalment plan on small first payments, by *inspirational* publicity and solicitation, to persons who have never done any studying and who are not accustomed to self-denial. It is much easier to resolve to study than to study, and many are enrolled who do not become students. For the man who agrees to study and pay, and does not, we are not responsible. About two-thirds of those enrolled pay for their scholarships, occupy the status of a matriculated student in a college or university, and are entitled to the privilege of studying. Three out of every four of these are benefited.

Considering the amount of work involved in completing the courses, the circumstances of the students and the fitness of the textbooks for home study without assistance, it is not to be expected that many students will pass the final examinations and receive diplomas. The courses are complete; they describe all applications in a trade or profession, and many of them require a great deal of time and study. The electrical-engineering course embraces 5702 pages, and the architectural course, 5296 pages of instruction matter. To answer the examination questions of the complete coal-mining course will require the student to write 117,000 words, make 83 diagrams, and 14 drawing plates; the examination in the electrical-engineering course requires 120,000 words, 157 diagrams, and 39 drawing plates, and the architectural course requires 96,600 words, 101 diagrams, and 55 drawing plates. The average time taken by students to com-

plete the coal-mining course is four years and three months; to complete the electrical-engineering course, four years and two months, and to complete the architectural course, three years and eight months. The longest time taken by a student to finish the complete coal-mining course was 13 years and two months, the electrical-engineering course, nine years and 10 months; and the architectural course, nine years and five months.

One hundred thousand students have completed their courses in full, or have completed the preliminary papers of their courses and a number of the advanced papers, or have received a mark of 98 per cent. on an advanced plate in drawing, which is given to none but persons who have learned to draw. Over thirteen thousand of the latter have received diplomas or certificates of proficiency, the latter being diplomas for the shorter courses.

The first five hundred students were enrolled between October 16, 1891, and May 20, 1892, in the complete coal-mining course, the only course taught at the time. An examination of the records shows 385, or 77 per cent., completed one or more subjects of the course, and 46 completed the course. The average number of papers passed by students who sent in work, was ten. The majority were content with completing the papers on arithmetic, mensuration, and mine ventilation, which would qualify them to pass the examinations for mine foremen.

Many of these students have passed away, and of others we have lost all trace. We have compiled a list of 100, who, with few exceptions, were miners when they enrolled. Fifty of them are now coal operators, mining engineers, mine inspectors, or mine superintendents, and the rest are mine foremen.

No. 1. Thomas Coates, who is with us today, a miner when he enrolled, is a mine foreman.

No. 4. Joseph Knapper; then a miner, now an inspector of mines.

No. 16. Jesse Ainsworth; then a miner, now a mine superintendent.

No. 80. John H. Jones; then a miner, now a coal operator and millionaire.

These first 500 students did more studying than the average I. C. S. student. They nearly all enrolled without solicitation, to qualify for the examinations, and had a strong incentive to work. Over 77 per cent. completed one or more subjects of the course, while but one-half of all the students pass one or more of the subjects of their courses.

The 50 per cent. of students who pass in at least one subject of their course pass on an average three subjects; they complete arithmetic, geometrical drawing and mechanical drawing; or arithmetic, geometrical drawing and architectural drawing; or blow-piping, assaying, and mineralogy; or arithmetic, mensuration and mine ventilation; or any three of the 500 subjects taught by the schools; or they complete a single subject like arithmetic, or a course of 30 or 40 subjects. It takes the average student nearly four months to finish a subject; so that one-half of all the students study on an average one year with the schools. There can, therefore, be no question that 50 per cent. of the students are benefited.

Ninety per cent. of the students when they enroll cannot work fractions, and therefore those who complete only arithmetic are benefited. As the examples in arithmetic for each course apply to the trades of which the courses treat, a person mastering them learns arithmetic and at the same time many of its applications in his trade.

Having intended only that the I. C. S. textbooks for home study should be easy to learn, easy to remember and easy to apply, when a teacher assists by mail, we have found by trial that they are easy to learn, remember and apply without a teacher. It is our practice to furnish students, when they enroll, with a complete set of the texts of their courses, bound in half leather; they are furnished with another set in pamphlet form as they proceed with their studies. Many students complete one or two subjects of their course, send in no further work, and use their textbooks for home study without the assistance of their instructors.

Many courses are bought by engineers, managers of works, superintendents and others, with the intention of using them for study without the assistance of a teacher or for reference purposes. Others who intend to send their work for correction find that they can obtain from the bound volumes alone the knowledge needed for promotion and advancement, and send in no work.

WHAT ONE MINER (AND HIS WIFE) DID

The case of Michael J. McHale, G-728, who is here today as a guest of the schools, shows what men who have nearly everything to learn can accomplish with the I. C. S. textbooks without the assistance of the instructors. Mr. McHale, while working as a miner, was solicited by a representative one afternoon just after receiving his pay to enroll for a course. He was convinced that it would be to his advantage to study; but as he had received only $11 for the month's pay and had a wife and two chidren to support, he concluded to take the representative to his home and have him lay the matter before Mrs. McHale. She also was convinced that her husband should study, and although they could hardly see their way to do it, Mr. McHale enrolled and gave $5 out of the $11 as the first payment on his scholarship. He is now a mine foreman. Children were formerly put to work in and around the mines at very early ages, and Mr. McHale started to work when he was only 8½ years old. He says he knew nothing of arithmetic when he began. Having promised the representative that he would study one hour a day, he kept his word, and at the end of a year could extract square and cube root. While studying, he wrote an occasional letter to the schools asking for explanation of difficulties met in his studies. These were answered, but he received no other assistance, for he sent no answers to the examination questions of his course.

Recently one of the principals visited a number of localities and made careful inquiry to ascertain what proportion the students that use their textbooks for studying without sending in work for correction, and derive benefit by so doing, bear to the whole number that pay for their courses. He reported that 25 per cent. of the students are using their textbooks without assistance from the schools, and are deriving such benefit that they are enthusiastic friends of the institution. It is the opinion of those who have investigated the matter that this is a conservative estimate.

Counting those who used the textbooks for study at home without assistance from the instructors, 75 per cent. of the students are benefited.

INDUCEMENTS TO STUDY

The delinquents, the name coined for persons enrolled who will not study and do not pay, are a loss to the schools. The cost of enrolling and furnishing them with first work is more than the average amount received, and the fact that they undertake the work and fail to perserve deters others from enrolling.

Representatives start persons at their studies who cannot understand the printed instructions how to commence the work, and then help them to master the processes of arithmetic and solve difficult problems. They receive the same commission for reinstating a delinquent that they do for enrolling a new student, and it is a rule that delinquents must be induced to resume their studies and payments if it is possible to get them to do so.

If a person enrolled fails to send in work within 60 days, he is written to by the instruction department and advised to begin his studies; if he commences to study and stops, he is urged at intervals to resume the work. Last year 113,831 such letters were written.

Our encouragement department, at the request of salesmen who furnish particulars of the student's character and habits, writes about 15,000 letters per year. These letters, written by men of more than ordinary ability for this work, induce many to return to their studies.

Persons enrolled receive for a year, free of charge, the monthly publication *Ambition*. The purpose of this journal is to create a desire to profit from the advantages of study, stimulate to perseverance, and develop self-reliance.

It is made the duty of teachers and

representatives as they correspond with students or come in contact with them, to permit no opportunity to pass unimproved to impress upon them the great good to be gained by completing the courses of study; to convince them that the habit of study is not more difficult to form than other good habits, and that such habit once acquired carries with it the power of concentration, the quality most necessary to business success.

A department composed of teachers who show special fitness for the work, instructs those who find great difficulty in learning, and a particular instructor is assigned to a very slow student, with instructions to insure his success if it takes all of the teacher's time.

If the student so desires, his employer is informed of the progress he makes in his studies. As the student passes each instruction paper, he is notified that if he will send us the address of his employer, or an officer of the company for which he works, or of any other person whom he wishes to be informed that he is studying, the instructor will write such person and inform him that the student has completed the paper.

STUDENTS' AID

Our students' aid department writes letters for students out of work, or desirous of changing their work, to the persons to whom they are applying for employment, giving their school history. The students' aid also assists students out of work, or seeking a change of work, in finding employment, and furnishes draftsmen, mechanics and others with special training, to employers in need of them.

On the payment of a transfer fee of $1, a delinquent student is transferred to another course of instruction, if he thinks he can do better than in the course for which he is enrolled.

Delinquency in payment does not suspend a student's privileges. The instruction records are not checked against his account. As in the winter months we correct the work of 20,000 students a week, this saves expense, and besides, a student who obtains advancement through his studies, even if he does not pay, is worth something to the schools. We do not, however, give a delinquent who studies through his course and passes his final examinations, a diploma, until his account is paid in full.

We are now holding the diplomas for a number of delinquents. A student in Michigan, enrolled three years ago, completed the sheet-metal pattern-drafting course last week, although he had made only the initial payment of $5 on his scholarship.

FRANKLY COMMERCIAL AND REQUIRING LARGE CAPITAL

The business requires large capital. The textbook plates for the courses of instruction cost $1,500,000. The buildings, printing plant, and furniture represent an expenditure of $1,000,000, and there is invested in stocks of paper and publications to conduct the business, $500,000. The scholarships are sold on the instalment-payment plan and the accounts receivable amount to $3,500,000. We have $100,000 invested in cars used in instructing railway employees, and are the largest importers of drawing instruments in the United States.

This is a commercial enterprise. It is necessarily so. The capital could not have been secured unless dividends were earned and paid. That the money to commence the business was obtained was surprising to many, because it was an experiment. The idea of conducting a large school of any description and making it pay was new. It would have been impossible to secure millions at the start, but the beginning was small; a profit was made each year and the necessary capital taken in as the business grew.

There are four thousand stockholders, among whom are many successful students. They invest in the stock of the company because they believe that the most permanent and profitable business enterprises are those supplying a general want; that at this time when capital and industry, as well as education and invention, have joined hands in improving the conditions of living, there is as great a demand for trained brains as there is for food or clothing; and that a technical school conducted on the lines this is, with so wide a field of operation, should be as profitable as a mine or a mill or a tobacco factory or a brewery.

THOROUGHNESS

But because the business is conducted on a commercial basis, it does not follow that the service performed is inferior to that of other educational institutions, part of whose income is derived from endowments or to such as are maintained by the State or National Governments.

Home study under a teacher who directs and assists the student by correspondence is more difficult than study where the recitations are made to a present teacher. But its greater difficulty is compensated for in its stronger influence in developing the traits of character that make most for business success—self-reliance, concentration and exactness.

The student who educates himself studying at home after working hours proves his strength, and ever after has confidence in himself. Without a teacher, he acquires the habit of concentration, and in writing the answers to the examination questions, he learns to work accurately. This is coming to be known by employers, many of whom, in seeking help, give preference to I. C. S. students. Even the certificates of progress, attached by the instructors to corrected recitations, are helpful in obtaining positions and promotions.

The rules of a home-study school conducted for profit, as this is, are made to suit the convenience of the student and not of the teacher. An I. C. S. mining student may begin his studies in the coal mines of Pennsylvania, continue them while prospecting in Alaska, and finish them in the goldfields of South Africa. He studies one hour a day or one hour a week, as he feels inclined. Some students take one month to finish the algebra of the mechanical course in which the subject is treated only as far as quadratic equations, while others take eighteen months. Students frequently quit studying for years, and then take up the work where they left off. In our contract we provide that we will issue diplomas only to such students as pass final examinations to our satisfaction, but we agree to teach the student until he is qualified to pass the examination. We have a few students unable to understand the principles taught, who have been through the courses two or three times, and are still unable to pass the examinations.

To get new business we must satisfy our customers. The student must have value for the money he pays or he will not recommend the school to his fellows. We cannot afford to offend, and the rule is to do more for the student than we contract to do, and to meet his demands on our time and resources, provided that it is possible to do so. We receive hundreds of letters every week from students asking for technical information not covered by their courses of instruction, and which we are not under obligations to answer, all of which are carefully answered. I have known a principal to spend three days answering a question which we were not required to answer. We cannot answer all questions of this character, but we can and do tell the inquirer where, in our textbooks or in others, he can find the knowledge wanted.

It will be apparent that regulations such as these largely increase the labor and expense of teaching, yet as the regulations must in all particulars suit the conditions and convenience of the student, and not those of the teacher, they are our practice.

It is more difficult teaching by mail to say "No" without giving offense than for the teacher who has the student before him; yet because we must please, we find a way to meet the demands of the unreasonable and exacting, and hold their good will. The business is conducted for gain, but with gain as the motive influencing his teacher, the student fares as well as when he is the beneficiary of the State or of the philanthropist.

THE VOLUME OF BUSINESS

Some idea of the volume of business done by the schools and the work involved in disposing of it may be obtained from the following data:

In the school year ending May 31, 1906, there were examined and corrected 743,754 sets of examination questions to in-

(*Continued at page* 589)

AMERICAN MACHINIST

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Justice to the Heirs of a Deceased Partner

A short while ago, in connection with the announcement of the addition of a new member to the firm of Robert W. Hunt & Co., of Chicago, we mentioned the fact that owing to an arrangement made at the organization of the firm, the widow and children of the recently deceased member, Mr. Fiero, would continue to receive the benefit of his share in the firm for a period of three years.

This attracted our attention as being rather an unusual provision of a partnership agreement and we wrote to Mr. Hunt, saying so, and asking for information about it, and particularly in regard to the considerations that led to its adoption. It is sometimes a pretty serious matter both to the heirs of a deceased member of a firm and to the remaining members of it to equitably dispose of such interests, held by persons unable to contribute to the work or business of the firm. It often happens that for a time the payments made to such heirs are made willingly enough, but there comes a time perhaps when they are considered more or less onerous and there is a casting about for means and methods for throwing off what has come to assume the aspect of a needless burden. Any arrangement by means of which this difficulty can be provided for without the necessity for negotiating with heirs who may feel themselves, and who may actually be, more or less helpless—of settling the matter in accordance with a well understood agreement entered into by all the partners, which applies to all of them exactly equally, and which the heirs of a deceased member may feel confident was believed by the husband and father to be fair to all parties, possesses obvious advantages. Mr. Hunt very kindly replied to our letter, saying:

"In forming our partnership, we realized that no matter what success might attend our efforts, it would not result in the accumulation of material property, but that our accumulated capital would consist mainly of reputation, which would be due to the united efforts of all the partners. Hence we felt that it would be very unfair if, immediately following the death of any partner the interest of his heirs in the business should cease; for, of course, while results from the immediate personal efforts of the deceased partner would have terminated, the firm could not help but enjoy for some time at least, the impetus to the business which he had assisted in giving. This led to our agreement that a deceased partner's estate should continue to enjoy the benefits of his interest for three years from the date of his death, which seemed to us to be equitable to all parties."

In the case of an incorporated company it is usually possible to make some such an arrangement and is usually also advisable to do so where the holders of stock actively participate in the work of carrying on the business and where the almost inevitable differences of opinion arise regarding the relative monetary value of such services.

The Education of the Schools and of the World

We seldom devote so much space in a single issue to educational subjects as will be found occupied by an address which appears elsewhere this week. This address is one of two that were delivered the same week during celebrations which were in many respects very widely separated, yet in a sense closely related. The principal point of the address of Fred. W. Taylor, president of the American Society of Mechanical Engineers, at the dedication of the engineering laboratory of the University of Pennsylvania, was that graduates of engineering colleges usually lack a certain training in the practical affairs of life which can be gained only by contact and competition with men engaged in the work of making a living, or which at best is not furnished by any engineering school or college. Mr. Foster's address, delivered during the celebration of the fifteenth anniversary of the founding of the International Correspondence Schools at Scranton, dealt with the methods of educating men, most of whom have had little else but just that kind of experience.

In this respect, as well as in many others, the two schools are as widely separated as the poles. Whether or not it is desirable from economic and humanitarian standpoints, that young college men should, earlier in life than is now the case, be brought to a full realizing sense of its responsibilities and compelled to give up their more or less joyous and care-free existence is a question we will not enter into; that is for others—including physicians—to decide. But it is a fact that the majority of students of the correspondence schools are serious enough. Most of them have plenty of the sort of education which one gains by contact and competition with others who are making a living. It is this very competition and the strenuousness of it that is their main incentive to self improvement. The man who, while his wife does her evening work, uses the kitchen table for a desk, rocks the cradle with one hand and holds his lesson paper in the other in an effort to get an education may have been prompted to enter upon this work by the efforts of a correspondence-school "field man," but his main incentive is far deeper than that. He has no membership in a Greek letter society, and no college yell; his laboratory is in the shop where he earns his daily bread (and it is often a very good laboratory), but there can be

no doubt that he is in earnest. He knows full well who it is that suffers when he fails to do what is required of him, and knows that for him there are no 60 "cuts" per term. We dare not attempt to compare the results of these two widely separated methods of instruction. They are scarcely comparable and certainly are not competitive. Professor Kent, in speaking at Scranton, referred to the three distinct systems of education having to do with industrial matters, the college, the correspondence school, and the trade school. He hoped all would prosper and develop, each doing its appropriate and appointed work.

For our own part, if we allow our imagination to run a little, we see a time when perhaps there will be no hard and fast line between the periods of education and of active work—a time when, by reason of industrial, social and economic development, conditions of life will be easier, and when, as men's capacity for work and the personal incentive for it develop, they will work and as the perception of the need, or the realization of the desire for knowledge arises they will also study, each individual progressing in the direction he feels inclined to go and as far as his mental capacity or the balance which he himself strikes between his several desires may impel him—a time when all men will be always workers and also always students, with enough time to spare from both for recreation and full enjoyment of life.

The idea that men should within say 15 years be "educated," during which process they should do little or no work, and that, upon the completion of their "education" they should then be considered fit to enter the world's field of contest and thereafter have little or no opportunity for further study is, we believe, unnatural and all wrong. The play should gradually merge into work; study should accompany both and should go as far as the play or the work seems to call for, or may inspire to further effort, and in our opinion no one should be conscious of the time when his "education is completed" and he is to "go to work."

Correspondence instruction is to some extent in accordance with this idea, and so, also, is the elective system of the universities.

Instruction by Correspondence

(Continued from page 587)

struction papers, drawing plates and language phonograph records. There were 159,482 letters written in reply to students asking for explanations of difficulties met with in their studies. The postage paid at the Scranton postoffice was $105,468. An average of 9000 persons were enrolled per month, 6000 of whom matriculated. We have 75,000 instalment accounts, and collect on 50,000 every month. The students do not pay regularly, the average being two payments every three months.

The first year, the receipts of the schools were $14,991; the second year, $35,939; the third year, $73,844. Last year they were $4,200,000. Last month they were $425,000, which is more than in any previous month. We receive $40,000 per year from New Zealand; $30,000 per year from South Africa; the Canadian agencies send us $180,000 per year. The whole amount received in the 15 years that the business has been conducted is $28,775,000. There has been paid $2,300,000 in dividends to the stockholders.

SCOPE OF THE WORK

We have an instruction department in San Francisco, and are about opening an instruction department in Wellington, New Zealand, for students in Australasia. The instruction department at Wellington will reduce the time between the students in new Zealand and the school two months.

We are arranging to do special work on the vessels of the United States Navy. Of the 17 warrant officers promoted to be commissioned officers under the recent Act of Congress, 13 are I. C. S. students.

We bind our textbooks and library of technology in half cloth and leather, and are the largest individual publishers of books in that class of binding in the world.

The field for the work is commensurate with the industries of the country. The American artisans working in the trades covered by our courses, number millions. The total enrolment of the schools barely exceeds the number of carpenters in the United States. Teaching the theory of their trades and professions to persons already employed is only one branch of the work; other equally important branches are the preparation of dissatisfied persons for more congenial occupations, and giving to young persons about to enter the trades, technical training to enable them to advance more rapidly than they otherwise would.

Every year approximately 1,650,000 young men and women reach the age of 21 in the United States. Of these, only a few thousand enter scientific colleges and institutes. Many of these leave before graduation and in time become customers for mail courses, as do many of the graduates who buy the instruction papers because they are more practical than regular textbooks.

However, the work of the schools is not confined to the artisan and laboring classes. We have courses that business men and young men and boys who expect to become business men should study. They are the courses in banking, commercial law, window dressing, showcard writing, and advertising. It is as important for a business man to have a knowledge of advertising as it is that he should know commercial arithmetic. We have thousands of female students, many of them taking the arts and crafts courses in which drawing, illustrating, and designing are taught; and many are studying French, German, or Spanish with the phonograph, in the interest of culture alone.

The field cannot contract, but must expand. In the world's requirements for trained heads as well as trained hands, no backward step will ever be taken. Not only will the demand for technical education continue to grow in established industries, but it will be increased by the development of new industries.

In concluding this paper, let me say that the I. C. S. is doing more than making skilled brain workers to direct and develop the industries, more than training inventors to seek after the 999 parts of truth which Mr. Edison says the race has still to learn. Its representatives are working in every city, town, and village of the country, inducing men to give up idleness and spend their spare time in study. It takes the careless off the street corners, out of saloons, pool rooms, and bowling alleys, and, by preventing the waste of money on drink and useless pleasures, puts clothing on the backs and food in the mouths of wives and children.

It inspires to self-denial, works for concentration and accuracy, and develops self-reliance, and thus makes forceful men, who do things. Such men are the reliance of the State; the workers whose intelligence, industry, and courage keep the country in the forefront of progress.

Teaching by correspondence is not new, but the plans that we employ to make it efficient and obtain its use by the people are new. We have opened a new field of educational endeavor in which the work of the teacher is made more effective by the invention, by the advertising knowledge, and by the executive and organizing power of the business man.

When we succeeded in producing textbooks that removed many of the difficulties and lessened the labor of the home student, there was revealed an educational light which, brightened by advertising and salesmanship, has shone around the world, and benefited hundreds of thousands.

A plan of teaching so far reaching that, operated in an interior city of Pennsylvania, it can educate and make better men and citizens of working people in New Zealand and South Africa, is something worthy the encouragement of all interested in the improvement of the individual and the elevation of the race.

The Standard Roller Bearing Company, of Philadelphia, reports that they are hardening and grinding six-inch balls for bearings, with entire success. One of these balls weighs 35 pounds and is equal in weight to 980,000 balls 1/16 inch in diameter, of which last 28,000 make a pound.

NEW TOOLS AND MACHINE SHOP APPLIANCES

A 14-INCH ENGINE LATHE

A good idea of the general appearance of this lathe may be obtained from the half tone, Fig. 1. The spindle, which is of hammered crucible steel, runs in phosphor bronze boxes, measures 2⅞ inches diameter at the front bearing, and has a 1-9/16 inch hole bored through. The centers are No. 3 Morse taper. The driving cone takes a 2½-inch belt, and the four steps range in diameter from 4⅛ to 9⅜ inches. The back gear ratio is 9.2 to 1. The carriage and tool rest have easily adjusted taper gibs and a graduated cross-feed dial gives readings to 0.001 inch. The carriage also has a chasing dial which enables the operator, when cutting threads, to catch the thread at any point without stopping the lathe or reversing the lead screw. Power cross-feed is provided, and the longitudinal feed has automatic stops in either direction. The feeds can be reversed by a lever, and also by a handle at the front of the apron. The mechanism is so arranged that the screw and rod feeds cannot be engaged at the same time. Also, when cutting threads, the rack pinion can be dropped out of mesh if desired. The feeds are gear driven, and three rapid changes are provided for either threading or turning, the range being greatly increased by change gears included in the equipment. The threads that may be cut include 11½, and range from 2 to 96 per inch. When required, gears and lead screw are provided for cutting metric threads. The interior of the apron is represented in Fig. 2, and Fig. 3 shows the gear-box mechanism and the construction of the automatic stop for the feed. The stop consists of a clutch gear and a key in the feed rod. The gear *A* has incorporated in it a clutch ring *B*, which is held in place by the cap *C* and the screws as shown. In ring *B* are cut three series of clutch openings, in which the key in the feed rod engages. This key is held in its normal position in the clutch by means of the springs *D D*. When the stop pin in the apron engages a collar on the feed rod (which collar has already been set in position), the feed rod is moved in the direction the apron is traveling until the key is moved out of engagement with ring *B*, when the feed stops. When the carriage is drawn back, the spring which has been compressed immediately returns the feed rod to its original position, thereby engaging the key with the clutch ring. The above operation can, of course, take place in either direction. The lathe swings over the bed 15 inches, and over the carriage 9½ inches. With 6-foot bed, the swing between centers is 3 feet 2 inches. The two-speed countershaft is provided with two 10x3¼-inch friction pulleys, and should be driven at 115 and 150 turns per minute. The lathe weighs with 6-foot bed, 1500 pounds. It is built by the Champion Tool Works Company, Cincinnati, Ohio.

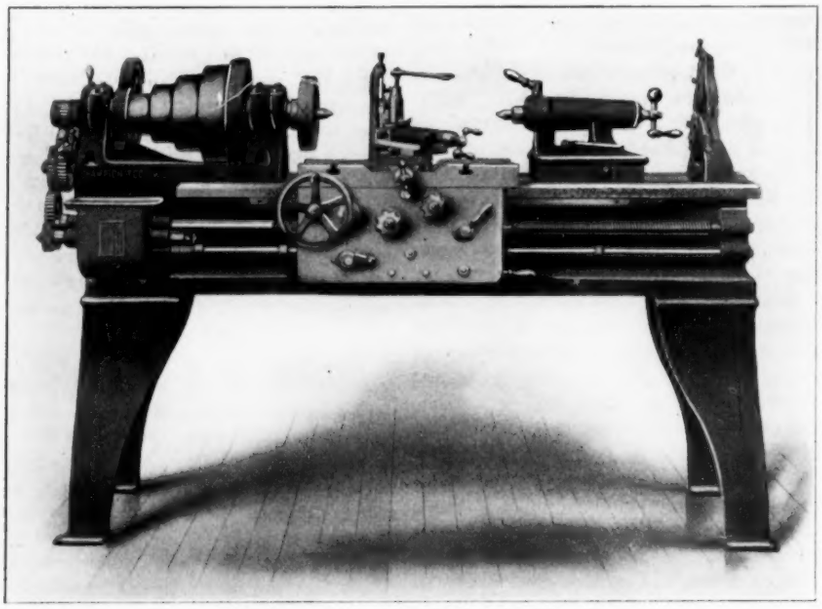


FIG. 1. 14-INCH ENGINE LATHE

AUTOMATIC PINION CUTTING MACHINE

This machine is constructed especially to cut steel pinions of coarse pitches at as fast a rate of feed as the cutters will stand. It is therefore suited for manufacturing purposes, where quantities of similar gears are required to be cut, also for jobbing since it is capable of cutting coarse pitches in iron, bronze and steel up to its full capacity, which is 30 inches diameter, and is particularly adapted to such work as the cutting of street-car motor pinions and gears. The machine is shown cutting such a pinion, using a roughing cutter and a finishing cutter side by side.

This machine, while classed as a pinion cutter because of its being designed specially for the rapid handling of work of from say 6 to 20 inches diameter, is nevertheless suited to the cutting of as coarse pitches as can be handled on the regular 60-inch machine of the same build. That is, while its maximum capacity is limited to the diameter noted in the opening paragraph, it will cut teeth as coarse as 2 and 3 diametral pitch; and yet the

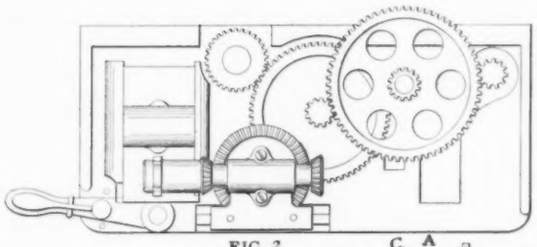


FIG. 2

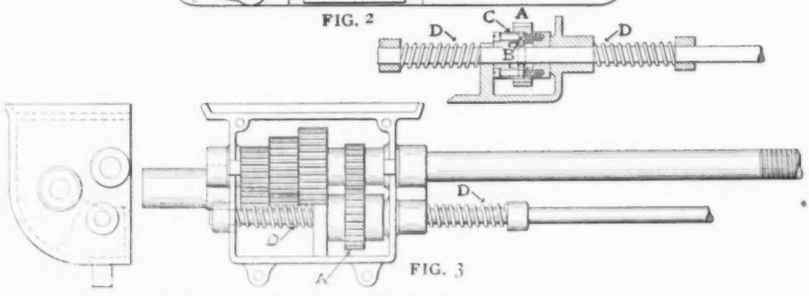


FIG. 3

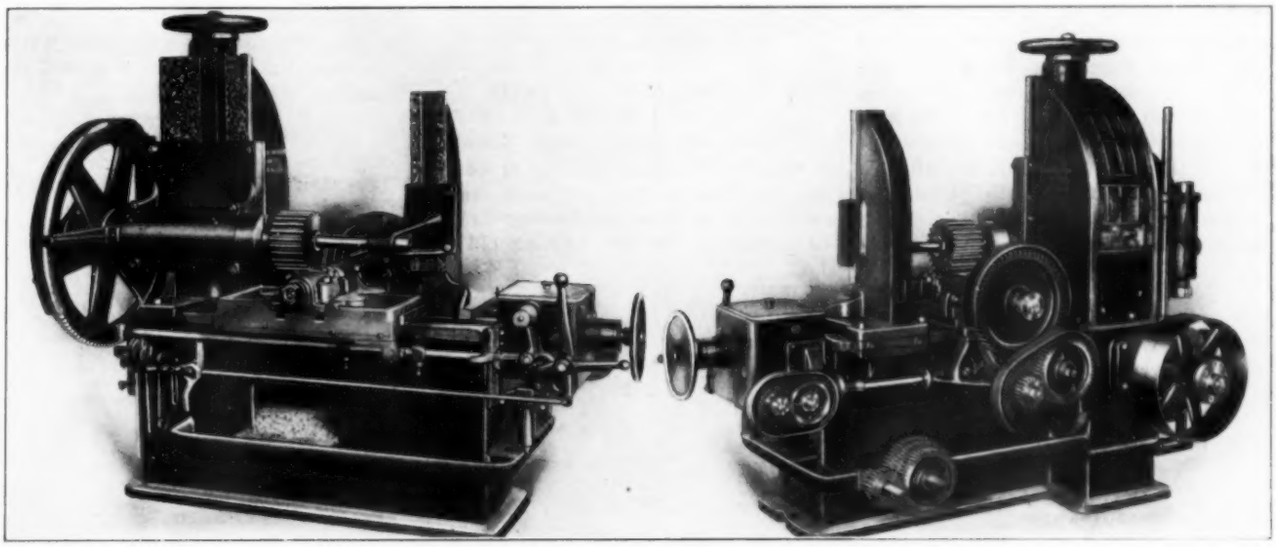
APRON AND FEED GEAR MECHANISM OF 14-INCH LATHE

columns are no longer than necessary for "pinion" work. As a matter of fact, the machine has the same powerful drive and spindles as the 60-inch machine, but has special short columns.

The nature of the work being special allows of the omission of some of the parts required only when cutting large gear wheels, and also permits of some simple adjustments, this being illustrated in the arrangement of the depth-adjusting hand wheel, etc. The main features are the long cutter slide, with the cutter spindle placed in the center, and the thrust for the feed screw, which is so placed that the screw draws the cutter slide to the work instead of pushing it, these features tending to eliminate chattering, particularly when taking heavy cuts.

The cutter spindle is a tool-steel forging of large diameter and is driven by means of a large, smooth-running spur gears. The changes of the cutter speed are made by means of the gears, as close to the last driver as possible, this method of gearing-up permitting the driving shafts to be kept at a high constant speed, thus subjecting them to less torsion than would otherwise be the case.

The cutter speeds and feeds are independent, so that one may be changed without affecting the other. The indexing and feed mechanisms are so constructed as to preclude simultaneous engagement of the two. Thus, while the machine is indexing, it is impossible for it to feed, and while feeding, the indexing lever cannot be operated. These movements are automatically interlocked, whether the machine is in operation or being adjusted by the operator. The indexing wheel is of large diameter; a graduated dial reading to thousandths of an inch is placed under the elevating hand wheel to facilitate accurate setting to the depth to be cut; the work arbors are drawn in and forced out positively, by means of a bolt at the rear end of the spindle. The machine is of heavy construction throughout and the frame is so designed as to form an ample reservoir for the cutting lubricant. A guard close up to the cutter causes the chips to fall directly into the base of the machine; they may be removed either at the side or front. Suitable strainers are of course provided for separating the chips from the lubricant. The machine is built by Eberhardt Brothers Machine Company, Newark, New Jersey.



AUTOMATIC PINION CUTTING MACHINE.

A BENCH MILLER—A MILLING ATTACHMENT FOR THE BENCH LATHE

Fig 1 represents a new bench milling machine which consists in part of some of the attachment for the Cataract bench lathe. The table of this miller drops 7 inches from the center of the main spindle, is 12 inches long and has power cross feed when driven by the regular screw-cutting attachment used for the bench lathe. All feed screws are supplied with 1½-inch index reading in thousandths, constructed the same as for the slide rest of the lathe. The machine is obviously very useful in getting out die and jig work. The main head is the same as is used for the No. 3 Cataract lathe, the spindle having ½ inch capacity clear through. The dividing head measures 2½ inches to centers and has a 4-inch index plate. It admits the No. 3 chuck, thus interchanging with the head. The same dividing head is used in connection with the adapter shown to the right in Fig. 1 with a footstock in place, this enabling one to get any angle of head to 45 degrees. It is especially suitable for small taper and tap work as the footstock can be kept in proper alinement. A vise is made for this miller, adapting it to a variety of small work. A milling attachment for the same bench lathe is shown in Fig. 2. This is identical with the bench miller with the ex-

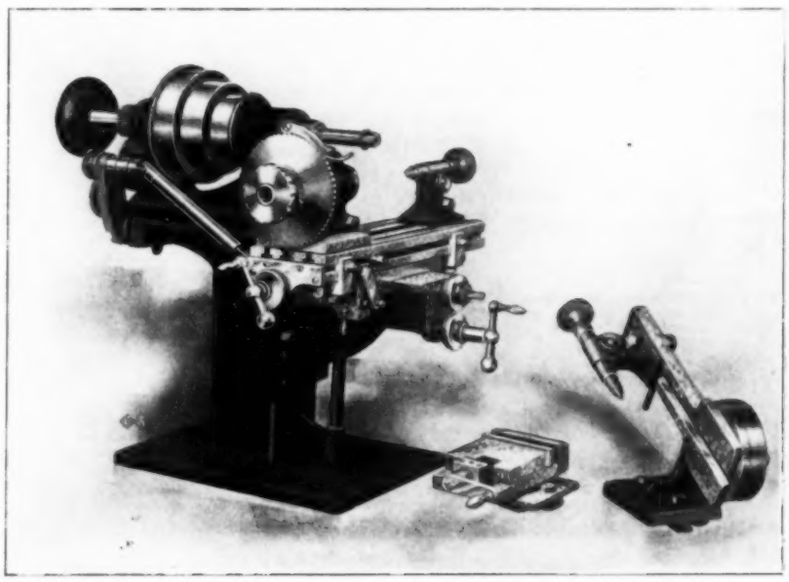


FIG. 1. BENCH MILLER

ception of the main frame. The proper hight for the frame above the bench is obtained by raising the head 3 inches above the top of the bed. As will be noticed, the apparatus is shown as used with the combined bench and countershaft arrangement illustrated at page 31. The countershaft with this arrangement is carried by the gas-pipe uprights and has two cones whose shafts are connected by a pair of gears, the cone for driving the milling attachment being 3 inches higher than the one for the lathe head, so that one can take the head from the lathe and place it upon the milling machine and still retain the same length of belt. As the same countershaft, lathe head, and screw attachment are used as with the lathe, the attachment for milling can be

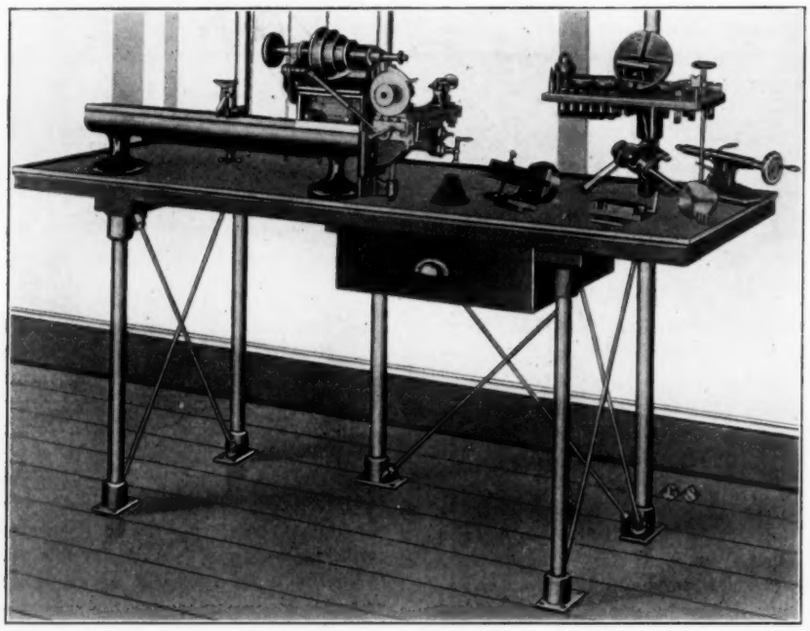


FIG. 2. MILLING ATTACHMENT FOR BENCH LATHE

applied quickly. The shifting of the countershaft belts is accomplished by the rods at the rear, but foot treadles can be used where desired. The countershaft brackets carry also a splined shaft for a high-speed grinder pulley. Where required, the countershaft can be made to go on the wall in the usual fashion instead of on the 1¼-inch gas pipes. The manufacturers are Hardinge Brothers, Chicago, Ill.

The Unveiling of a Historical Tablet

On October 27 a tablet—on the Schieren Building at the corner of Ferry and Cliff streets, New York City—was unveiled. The ceremony was under the auspices of the Hide and Leather Association of New York. The various speakers were introduced by William McCarroll, president of the Hide and Leather Association. The speeches by Messrs. James William Beekman, N. Y. Historical Society; Josiah T. Tubby, and Richard Young were intensely interesting. After the speeches an illuminated address was presented to Chas. A. Schieren, Sr. An informal lunch followed.

The tablet is a very handsome bronze affair. On either end of it are figures in bas-relief of leather workers. In the center runs the legend:

The
Schieren Building
Erected 1905
This site a part of the historic
"Old Swamp"

Formerly the Northernmost Boundary of the city and largely devoted to tanneries, has been occupied for more than a century by the Hide and Leather Trades. In excavating for this building old tan tubs were found in a good state of preservation, containing tan bark over one hundred years old.

Obituary

Benjamin Howard Warren, a well known engineer, died suddenly Saturday morning, October 20, at the Hotel Collingwood, New York city, of cerebral apoplexy. Mr. Warren was a retired engineer officer of the United States Navy. He had also been vice-president of the Westinghouse Electric and Manufacturing Company, Pittsburg, Penn., and president of the Allis-Chalmers Company, of Milwaukee, Wis. Within the past year he had engaged in business as consulting engineer at 60 Wall street, New York, in partnership with John C. Kafer, whose death occurred last April, and A. M. Mattice, a lifelong associate in the navy and in business. He was at one time with the Hancock Inspirator Company, Boston, Mass., and for a year was in the office of the Pratt & Whitney Company, Hartford, Conn. Mr. Warren was 57 years old. He was a member of the American Society of Mechanical Engineers almost since its organization, having been elected in June, 1880, and was vice-president of the society from 1898 to 1900. He was one of the foremost members of the Engineers' Club, a member of the University and Lawyers' clubs of New York, and of other organizations. His home was at Alberene, Va. He leaves a widow, two daughters and a son.

Manufacturers

The Hoopeston (Ill.) Horse Nail Company will double the capacity of its plant.

The Essex Glue and Gelatine Company, Peabody, Mass., is building a power house and boiler house.

Miscellaneous Wants

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad St., New York.

Wire and sheet-metal-working machinery and tools. Emmons Collins, Chicago, Ill.

Wanted—Gould & Eberhardt spur-gear cutter, capacity 60". Box 261, AMER. MACH.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Auto. machines designed and built. Geo. M. Mayer, M.E., 1131 Monadnock Blk., Chicago, Ill.

Runnerless slide rules. New method of operating. F. F. Nickel, 27 Winans St., E. Orange, N.J.

Light, fine machry. to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Dies and Diemaking, $1.00. A shop book by a shop man. J. L. Lucas, Bridgeport, Ct.

Novelty in tool or machine specialty wanted. Particulars required. Box 202, AMER. MACH.

Special machinery designed and built. Walter S. McKinney, M. E., 43 Broadway, Flushing, N. Y.

Tools, dies and special machinery built by contract. Chas. Crabb Co., 635 Kent avenue, Brooklyn, N. Y.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Special machinery to order. Catalog of small engines and boilers and engine castings 10c. Sipp Elec. & Mach. Co., Paterson, N. J.

Universal grinding machine, about 12x32, new or second-hand, first-class condition, wanted; immediate delivery. Box 237, AMERICAN MACHINIST.

A technical-school graduate of over ten (10) years of practical experience desires some evening work of a technical nature. Box 262, AMERICAN MACHINIST.

Wish to place contract for yearly supply of gray-iron castings, similar to gas-engine castings; about four tons daily. R. X. Y., Box 283, AMERICAN MACHINIST.

Special machinery, tools, prime movers designed and working drawings furnished on short notice. Inventions perfected. Engineer, 921 Fulton Building, Pittsburg, Pa.

A large English firm of machine-tool importers, having showrooms and offices in France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Special high-grade machinery built to order. Automatic and otherwise electrical work a specialty. Complete modern equipment. Automatic Machine Development Company, 130 East 12th street, New York.

Not using the whole of our modern factory plant, we should like to take up the building of any small high-grade machines, or parts of machines, in large or small quantities. United Sewing Machinery Company, Springfield, Mass.

Engineers' Handbook of Standard Dimensions of Details and Machinery, 250 blueprinted tables, leather bound, sent prepaid on receipt of price, $3.50. M. Neumayer, M. E., First National Bank Building, Cincinnati, O.

Wanted—Address of F. A. Oakley, employed in 1899 with Pratt & Whitney, of Hartford, Conn., as foreman of model department. Address James H. Dean, care Dean Ballot Machine Company, Minneapolis, Minn.

Salesmen—Excellent openings for men familiar with machinery, mechanical tools, etc.; preference given to those commanding trade; strictly high-grade propositions; salaries, $1000—$5000. Write us today. Hapgood's, 305 Broadway, New York.

Be an expert steel worker by using Toy's Treatise on all new steels and welding the different kinds of steel solid; also two colored tool-tempering charts, hardening and tempering all tools to a standard—all for one dollar. Valuable samples free. W. M. Toy, Sidney, O.

The J. Geo. Leyner Eng. Wks. Co., of Littleton, Colo., are increasing their plant and are in need of good mechanics, machinists, blacksmiths and sheet-iron workers. Littleton is a suburb of Denver, where cost of living is reasonable; superb climate the year round. **Address above.**

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, **New York City.**

Be a draftsman making $150 monthly by taking individual instructions from chief draftsman of large concern, who will in a few months' home study equip you fully with complete drafting-room knowledge and practical experience to start you at $20 or $30 weekly salary and rapidly advancing. Furnish all tools free of charge, and a steady position when competent. Reasonable terms and success guaranteed. Write at once. Chief Draftsman, Division 4, Engineers Equipment Company, Inc., Chicago.

Business Opportunities

Dividend-paying iron-works company wants business or technical partner; must buy interest; good salary. Box 278, AMER. MACH.

Manufacturing company, 50 years old, wants good general man; must buy dividend-paying stock; good salary; bank references. Box 280, AMERICAN MACHINIST.

Machine business desires partner; must invest; old established; money-making; highest bank references; want good business man. Box 279, AMERICAN MACHINIST.

Experienced mechanical engineer, patentee new gas engine, desires communication with up-to-date machine concern with view to doing business. Box 259, AMERICAN MACHINIST.

Negotiations desired with a machinery builder having facilities to manufacture tools from 1000 to 6000 lbs., and wishing to extend his business with an established and profitable line. An Eastern manufacturer preferred. Box 248, AMERICAN MACHINIST.

Wanted to contract with shop within 50 miles of New York City, equipped for making highest-grade automobile chassis. Must have capacity for at least 100 cars per year and able to do highest grade interchangeable work cheaply. No body work. Box 210, AM. MACH.

Wanted—Capital to develop basis for big industry. Noiseless, visible, returnless-carriage typewriter. Writes continuously start to finish. Carriage inertia at least tenth that of others—hence accuracy, great speed and practically noiseless. This from technical man with years of practical experience; references furnished and required. Box 287, AMERICAN MACHINIST.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the construction of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—One Binsse No. 1 B horizontal boring machine with 36-inch table; brand-new never used; will trade for No. 4 plain Cincinnati milling machine, if in good order. Continental Motor Mfg. Co., Muskegon, Mich.

For Sale—Hydraulic press, W. S. Co. make, practically new; steel cylinder will stand 2000 lbs. per square inch; ram 16″ diameter, 12″ raise; platens 31½″x48″, cored for steam or water. The Duranoid Mfg. Co., 219 Chestnut St., Newark, N. J.

For Sale—A modern equipped machine shop doing a general jobbing trade, with a good line of customers, in one of the best manufacturing towns of Indiana of 20,000 inhabitants; building can be leased on reasonable terms; good reasons for selling. Address Standard Motor Co., Kokomo, Ind.

Wants

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Assistant general manager, technical graduate, desires position with engine or machinery manufacturing plant. Box 243, AM. M.

Thirty-five years of age, wide and varied experience; now in charge of wood and metal pattern departments and foundry experiments in large concern; familiar with modern physical and clerical shop and foundry practice; open for position as assistant superintendent or similar position of authority; high-grade references. Box 294, AMERICAN MACHINIST.

MASSACHUSETTS

Position wanted by factory manager; technical engineer; thorough knowledge of modern mechanics; specialist in foundry and machine-shop production; diplomacy and tact in handling of labor highly endorsed; record clean and will stand fullest investigation; age 35; compensation to be arranged; can report on 30 days' notice. Address "American," Box 273, AMERICAN MACHINIST.

MICHIGAN

Machine shop foreman, 30, broad gage, inventive ability, able executive, thoroughly up-to-date, modern shop practice, automobile or light interchangeable machines; references. Box 140, AMERICAN MACHINIST.

NEW JERSEY

Mechanical draftsman wishes postion. Address Box 264, AMERICAN MACHINIST.

Experienced mechanical draftsman desires position. Box 228, AMERICAN MACHINIST.

Mechanical draftsman wants position; five years' shop and three years' drafting experience. Box 284, AMERICAN MACHINIST.

Situation wanted as draftsman or master mechanic in textile mill; 18 years' experience; desires change. Box 263, AM. MACH.

Special work evenings by technical graduate near New York City; 10 years' experience on plant layouts, design, manufacture and operation of steam-engineering apparatus. Box 276, AMERICAN MACHINIST.

Mechanical draftsman—29, German graduate, 3½ years shop, 7½ years drawing-office work in general machinery, electric and pneumatic hoists and cranes, steam boilers and engines, since four years in the United States—wants to change his present position. Box 267, AMERICAN MACHINIST.

NEW YORK

Experienced mechanical draftsman desires work for spare time. Box 289, AM. MACH.

First-class mechanical draftsman wishes work to do at spare time. Box 297, AM. M.

Draftsman seeks position; best references from automobile and general machinery manufacturers. Box 286, AMERICAN MACHINIST.

Mechanical draftsman, 7 years' office and shop experience at water meters, tools, and fixtures, etc., technically educated, desires change of position. Box 296, AMER. MACH.

Inventor, with 10 years' experience in steam engines, automatic machinery, die work and steam turbines, is open for a first-class engagement. Box 252, AMERICAN MACHINIST.

Machine shop and foundry superintendent, with good business experience, desires change; executive, progressive, successful; present position outgrown. Address Box 288, AM. M.

General foreman—successful in the modern economical manufacture of high-grade machinery, varied experience, master machinist—desires change; age 36; salary $150. Box 285, AMERICAN MACHINIST.

Situation wanted near New York—Experienced as general foreman of toolroom or manufacturing department, producing small interchangeable parts or small machines; 15 years' experience; age 35. Address Box 260, AM. M.

WISCONSIN

Designing draftsman with experience on machine tools, special machinery, jigs, fixtures and small tools; technical, practical and original. Address Box 275, AMER. MACH.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted — Experienced draftsmen on jigs fixtures and tools; give age, experience and wages expected. Ross Rifle Co., Quebec, Canada.

Wanted — Toolmakers experienced on fixtures, dies and gages. Applicants should give age, experience and wages expected. Ross Rifle Co., Quebec, Canada.

Wanted — An experienced tool designer; small interchangeable parts made in large lots; range of tools—punches and dies, jigs, milling fixtures, screw-machine fixtures and cams; a good opening for the right man. The Northern Electric and Mfg. Co., Ltd., Montreal, Quebec.

CONNECTICUT

Wanted—First-class operator on Jones & Lamson turret lathe; also one first-class all-around machinist. The New Machine Co., Danbury, Conn.

Wanted — Tool makers, die sinkers, drop forgers and men familiar with grinding machines. Apply to D. P. Beckwith, Pope Manufacturing Company, Hartford, Conn.

Salesman — Bright, energetic young man, having some mechanical knowledge; give full particulars, references and salary desired. Address Box 291, AMERICAN MACHINIST.

Foundry foreman—A reliable man to take charge of small foundry; must have thorough knowledge of gray-iron castings; state experience, references and salary wanted. Address Box 292, AMERICAN MACHINIST.

Salemen—We wish to engage good, live men who desire a good side line; only those having some mechanical knowledge and calling on the manufacturing trade need apply. Address Box 290, AMERICAN MACHINIST.

ILLINOIS

Wanted—By large wagon factory, experienced mechanical draftsman for work on traction trucks and heavy wagons. Box 238, AMERICAN MACHINIST.

Wanted—An experienced man on lathe and milling machine in a small shop, using new up-to-date tools; conveniently located in Chicago. Box 271, AMERICAN MACHINIST.

Mechanical draftsman wanted—A man with wide experience, thoroughly familiar with machinery drafting, and who has executive ability to take position as assistant of a large mechanical drafting department; prefer a man of college education; in answering, state age, experience and such other information as would be helpful in passing upon your application. Address all replies to Box 183, AMERICAN MACHINIST.

INDIANA

Wanted—First-class toolmakers and lathe men; increasing business, manufacturing automobile motors. Address Western Motor Co., Logansport, Ind.

MASSACHUSETTS

Wanted — First-class outside erecting men familiar with steam engines. Location near Boston. Box 212, AMERICAN MACHINIST.

Wanted—Draftsmen and tracers on printing-press work; state age, experience and salary required. Address Box 197, AM. MACH.

Mechanical draftsmen wanted for general machine work, also structural steel work; state age, experience and salary expected. Box 251, AMERICAN MACHINIST.

Mechanical draftsman wanted on medium-weight special automatic machinery; shop located in eastern Massachusetts; please send age, experience and references; steady work and good pay. Box 282, AMERICAN MACH.

Wanted—Two first-class machinists and one screw-machine operator; must understand Gisholt lathe; steady positions to competent men; state age and wages expected; factory near Boston. Box 270, AMERICAN MACHINIST.

Wanted—A superintendent for plant employing three or four hundred men; foundry, machine shop and manufacturing plant; thoroughly up-to-date and energetic man, preferably of technical education, familiar with pushing work through shop under the most modern conditions. Address, stating age, experience and compensation expected, Box 272, AM. M.

MICHIGAN

Wanted — First-class operators on automatic screw machines; also fine toolmakers, accustomed to fine jig and fixture work and sub-press work. Box 258, AMER. MACHINIST.

Several reliable, energetic foremen are wanted by Cadillac Motor Car Company, Detroit,

Mich. They must have a thorough mechanical training, experience in getting best results out of large bodies of men and be entirely capable of taking full charge of a machine shop. Write immediately, giving all information that would be of use in making a decision.

NEW JERSEY

Wanted—Working foreman for small shop building special and duplicate machinery; give references and salary expected. Address Box 2030, Paterson, N. J.

Draftsman, experienced on structural iron work, by manufacturers of electrical cranes near New York; state experience and salary wanted. Box 257, AMERICAN MACHINIST.

Wanted—Working foreman for small shop doing jobbing, mold work and building special machinery; give references and salary expected. Address "M," Box 201, AMER. MACH.

Several first-class tool and diemakers accustomed to high-grade work; steady employment and good wages to competent men. Sloan & Chace Mfg. Co., Sixth avenue and Thirteenth street, Newark, N. J.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Master mechanic for shop manufacturing heavy machinery; want an experienced and thoroughly up-to-date man; only those who state age, experience, references, salary expected, etc., with full particulars, will be considered; good opportunity for the right man. "B. S.," Box 269, AMERICAN MACHINIST.

NEW YORK

Wanted—Experienced men on general tool work; steady positions for the right men. Remington Typewriter Factory, Ilion, N. Y.

Permanent position for a good draftsman with a large concern in the vicinity of New York City. Box 293, AMERICAN MACHINIST.

Wanted — Experienced draftsmen, toolmakers and machinists; give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

At our new factory—Toolmakers experienced in fine and complicated work; steady employment and good wages. Jones Speedometer Co., New Rochelle, N. Y.

Draftsmen on jigs and fixtures for duplicating work; none but experienced men wanted; good pay for right men. Mergenthaler Linotype Co., 20-42 Ryerson St., Brooklyn, N. Y.

Man wanted to represent us on the road; one acquainted with babbitt, solder and type-metal trade and preferably employed at present. This is a good opportunity for the right party. Box 266, AMERICAN MACHINIST.

Wanted — Chief draftsman, accurate, with executive ability and extensive experience in Webb printing-press designing; to a competent man we can offer a permanent position at a good salary. Apply Box 182, AM. MACH.

Draftsman wanted by a company building elevating and conveying machinery; experience in the line specified is desirable but not absolutely essential; state salary expected, experience, and when at liberty. Box 281, AMERICAN MACHINIST.

OHIO

Draftsman wanted — State wages and experience. Box 230, AMERICAN MACHINIST.

Machine-tool draftsmen wanted for Ohio; detailers or designers. Box 245, AM. MACH.

Wanted—Designers and detailers on heavy machine tool work; state age and experience. Box 218, AMERICAN MACHINIST.

Wanted—Machine-shop foreman, inspectors and cost clerks; none but first-class men need apply; factory situated in middle West. Box 265, AMERICAN MACHINIST.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

The National Metal Trades Association can place a few first-class toolmakers, patternmakers and blacksmiths. Positions will be guaranteed as steady and at highest prevailing rate of wages. This is an opportunity for first-class men to secure one of the N. M. T. A. certificates of recommendation. For further particulars address The National Metal Trades Association, Cincinnati, O.

Wanted — Superintendent of a large and growing factory, employing now about five hundred (500) hands, manufacturing high-class electrical product, wishes an assistant thoroughly up-to-date on quick interchangeable work at lowest cost; a man to become master mechanic in time; this is an excellent opportunity. Reply, giving age, whether married or single, past experience in detail. All letters acknowledged and held confidential. Box 205, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—Ten machinists, lathe, planer, boring mill and bench hands; steady work. Apply to Scottdale Foundry & Machine Co., Scottdale, Pa.

Wanted—Experienced operator for Jones & Lamson lathe; steady work in a good town. Write Wilson Laundry Machinery Company, Columbia, Lancaster County, Pennsylvania.

Draftsmen—A large firm of engine builders in western Pennsylvania wants draftsmen and tracers. State age, education, experience, and salary expected. J. A. M., Box 45, Pittsburg, Penn.

Wanted—Foreman for boiler shop employing 75 to 125 men; one who can handle men to advantage and get out first-class work at a minimum cost; shop located in western Pennsylvania. Box 161, AMER. MACHINIST.

Draftsman wanted—First-class draftsman familiar with the design of power plants; all correspondence treated confidentially. Address, stating age, experience, reference, compensation received and expected. Box 268, AMERICAN MACHINIST.

Wanted—A number of first-class tool and diemakers; also an expert operator on Gisholt turret lathes; an excellent opportunity will be given the right man. Address Employment Department, Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

Wanted—Lathe foreman capable of producing good work at minimum cost for growing shop now employing forty (40) hands; good opportunity for the right man. Wilson Laundry Machinery Company, Columbia, Lancaster County, Pennsylvania.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections, these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND

Wanted—A few mechanical draftsmen, men with shop experience preferred. State age, experience and salary expected. Box 225, AMERICAN MACHINIST.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

WEST OF MISSISSIPPI

Molders and coremakers wanted for foundry in central California; must be steady industrious men, used to general work; references required. Box 295, AMERICAN MACHINIST.

Wanted—A first-class machine-shop foreman for large packing house; must be competent on all lines of packing-house machinery; state experience, reference and salary wanted. Box 277, AMERICAN MACHINIST.

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Bending Tools, Hand
Estep & Dolan, Sandwich, Ill.
Wallace Supply Co., Chicago, Ill.

Bicycle Parts
Standard Welding Co., Cleveland, Ohio.

Blanks, Nut and Screw
Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chains
See Hoists, Hand

Blowers
American Blower Co., Detroit, Mich.
Am. Gas Furnace Co., New York.
Boston Blower Co., Hyde Park, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., Chicago, Ill.
Garden City Fan Co., Chicago, Ill.
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Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Bros. Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines
General Electric Co., New York.
Keuffel & Esser Co., New York.

Boilers
Chandler & Taylor Co., Indianapolis, Ind.
Struthers-Wells Co., Warren, Pa.

Bolt and Nut Machinery
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Brown Co., H. B., Easthampton, Conn.
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Detrick & Harvey Mach. Co., Baltimore, Md.
Foote, Burt & Co., Cleveland, O.
Harrington & Son Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Lang Co., G. R., Cincinnati, O.
Northern Elec. Mfg. Co., Madison, Wis.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Machinery Co., Bowling Green, Ohio.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolts, Coupling
Cleveland Cap Screw Co., Cleveland, O.
National-Acme Mfg. Co., Cleveland, O.

Bolts and Nuts
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening
Rogers & Hubbard Co., Middletown, Conn.

Books, Mechanical
American School of Correspondence, Chicago, Ill.
Henley Pub. Co., Norman W., New York.
Hill Publishing Co., New York.
Sames, C. M., Jersey City, N. J.
Wiley & Sons, Jno., New York.

Boosters
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. & Mfg. Co., Madison, Wis.
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Sprague Elec. Co., New York.
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Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

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Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
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Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
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Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
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Toledo Machine & Tool Co., Toledo, O.

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Hammacher, Schlemmer & Co., New York.
Montgomery & Co., New York.

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Boston Gear Wks., Boston, Mass.

Carborundum
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Nolte Brass Co., Springfield, O.

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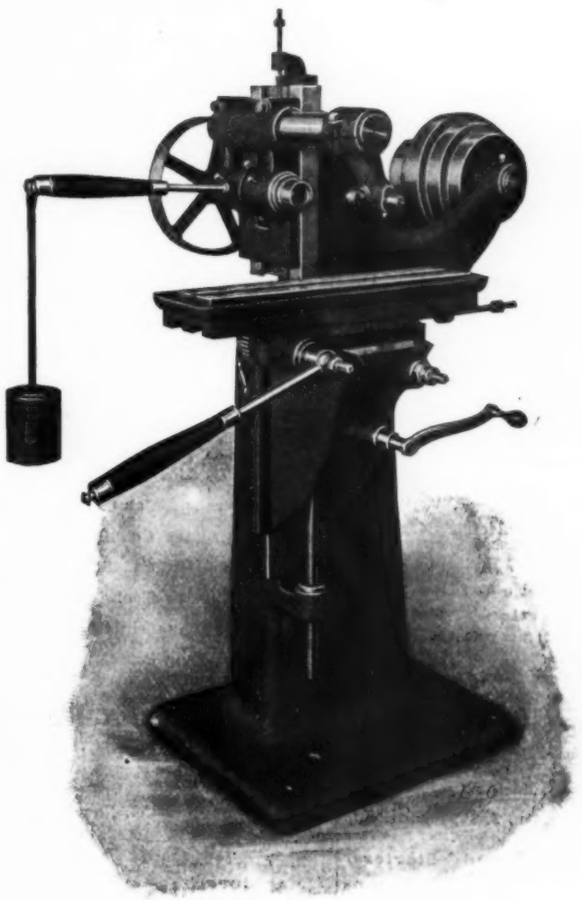

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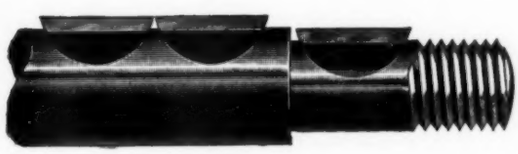

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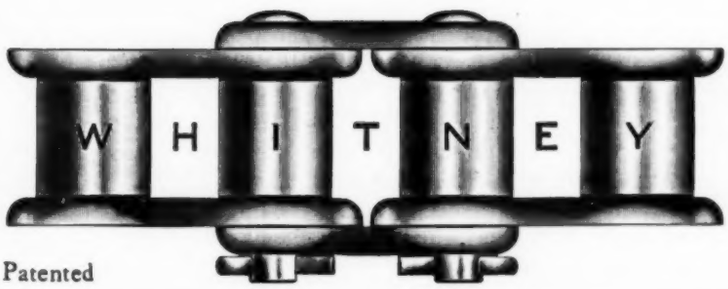

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Marshall & Huschart Machry. Co., Chicago, Ill.
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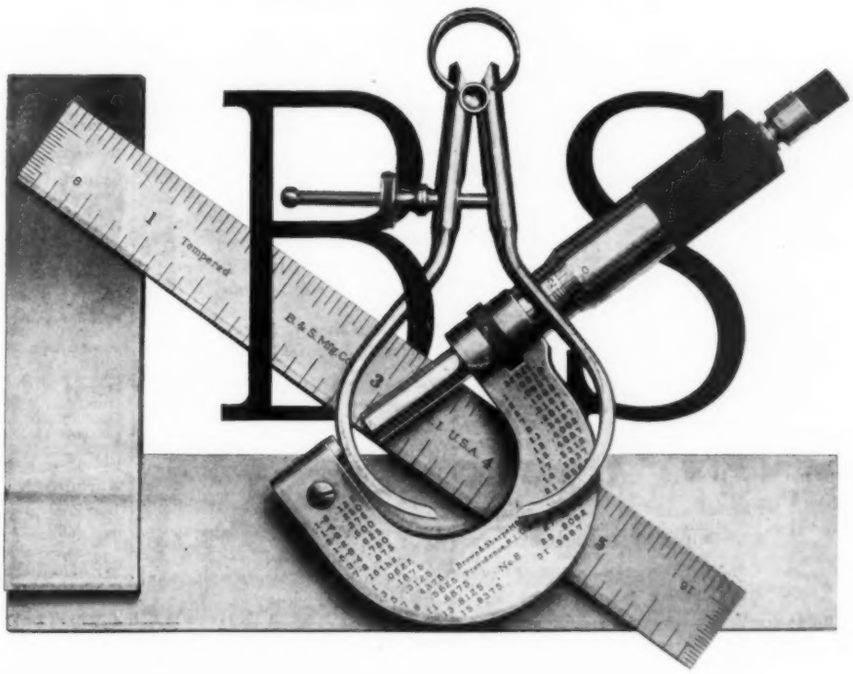

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National Separator & Machine Co., Concord, N. H.
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Davis Machine Co., W. P., Rochester, N. Y.
Fairbanks Co., New York.
Fenn Mach. Co., Hartford, Conn.
Fosdick Mach. Tool Co., Cincinnati, O.
Foote, Burt & Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Knecht Bros. Co., Cincinnati, O.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Machine Co., Hartford Conn.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.

Drills, Hand
Cincinnati Electrical Tool Co., Cincinnati, O.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Pneumatic
Chisholm & Moore Mfg. Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
International Steam Pump Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Foote, Burt & Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Curtis & Curtis Co., Bridgeport, Conn.
Hisey-Wolf Mach. Co., Cincin., O.
Parker Co., Chas., Meriden, Ct.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock
Ingersoll-Rand Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.

Drying Apparatus
American Blower Co., Detroit, Mich.
Boston Blower Co., Hyde Park, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
Eck Dynamo & Motor Works, Belleville, N. J.
Electro Dynamic Co., Bayonne, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. Co., Chicago, Ill.
Sprague Elec. Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies
Electro Dynamic Co., Bayonne, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. Co., Chicago, Ill.
Sprague Elec. Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery
American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Crescent Forgings Co., Oakmont, Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Roth Bros. Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

Emery Wheels
See Grinding Wheels

Emery Wheel Dressers
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Heald Machine Co., Worcester, Mass.
International Specialty Co., Detroit, Mich.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room
Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineers, Consulting and Mechanical
Dodge & Day, Philadelphia, Pa.

Engineers, Electrical
Crocker-Wheeler Co., Ampere, N. J.

Engines, Automobile
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Reeves Pulley Co., Columbus, O.

Engines, Gas and Gasolene
Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.

Engines, Gas and Gasolene —*Continued.*
Foos Gas Engine Co., Springfield, Ohio.
Foss Gasoline Engine Co., Kalamazoo, Mich.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Jacobson Mach. Mfg. Co., Warren, Pa.
Mathews, Hugh, Kansas City, Mo.
Mietz, August, New York.
New Era Gas Engine Co., Dayton, O.
Olds Gas Power Co., Lansing, Mich.
St. Marys Mach. Co., St. Marys, Ohio.
Struthers-Wells Co., Warren, Pa.

Engines, Oil
Mietz, August, New York.

Engines, Steam
American Blower Co., Detroit, Mich.
Boston Blower Co., Hyde Park, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Garden City Fan Co., Chicago, Ill.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engravers
Bormay & Co., New York.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads
Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery
Philadelphia Bourse, Phila., Pa.

Expanders, Boiler Tube
Nicholson & Co., Wm., Wilkesbarre, Pa.

Extinguishers, Fire
Badger & Sons Co., E. B., Boston, Mass.

Facing Machines, Portable
Underwood & Co., H. B., Phila., Pa.

Fans, Electric
Boston Blower Co., Hyde Park, Mass.
Crocker - Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust
American Blower Co., Detroit, Mich.
Boston Blower Co., Hyde Park, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
Garden City Fan Co., Chicago, Ill.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Feathers
Standard Gauge Steel Co., Beaver Falls, Pa.

Files and Rasps
Barnett Co., G. & H., Phila., Pa.
Hammacher, Schlemmer & Co., New York.
Heller Bros. Co., Newark, N. J.
Montgomery & Co., New York.
Nicholson File Co., Prov., R. I.
Reichheim & Co., E. P., New York

Filler, Iron
Clark Cast Steel Co., Shelton, Ct.
Felton, Sibley & Co., Phila., Pa.

Filing Machines
Cochrane-Bly Co., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Henry & Wright Mfg. Co., Hartford, Conn.

Fillets, Leather
Cleveland Fillet Co., Cleveland, O.

Flexible Shafts
Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Stow Mfg. Co., Binghamton, N. Y.

Forges
Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Burke Machinery Co., Cleveland, Ohio.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
Natitonal Machinry. Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop
Billings & Spencer Co., Hartford, Conn.
Crescent Forgings Co., Oakmont, Pa.
Lang Co., G. R., Cincinnati, O.
O. K. Tool Holder Co., Sheldon, Conn.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Hydraulic
Wyman & Gordon Co., Worcester, Mass.

Forgings, Steel
Baldwin Steel Co., New York.
Crescent Forgings Co., Oakmont, Pa.
Heppenstall Forge & Knife Co., Pittsburg, Pa.
Kent & Co., Edwin R., Chicago, Ill.
Tindel-Morris Co., Eddystone, Pa.
Wyman & Gordon Co., Worcester, Mass.

Foundry Furnishings
Adams Co., Dubuque, Iowa.
Byram & Co., Inc., Detroit, Mich.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Fuel Economizers
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Furnaces, Enameling
American Gas Furnace Co., New York.

Furnaces, Gas
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Obermayer Co., S., Cincinnati, O.
Westmacott Co., J. M., Prov., R. I.

Furnaces, Melting
American Gas Furnace Co., New York.

Furnaces, Oil
Tate, Jones & Co., Pittsburg, Pa.

Furnaces, Rivet
Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop
Hart & Cooley Co., New Britain, Conn.
Manufacturing Equip. & Engineering Co., E. Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gas Blowers and Exhausters
Sturtevant Co., B. F., Hyde Park, Mass.

Gages, Recording
Bristol Co., Waterbury, Conn.

THE NEW ENGINEERING BUILDING OF THE UNIVERSITY OF PENNSYLVANIA—II

Equipment of the Mechanical, Electrical and Chemical Engineering Departments (Continued)—The Civil Engineering Department and Its Fine Hydraulic Laboratory—An Extensive System of Testing and Drawing Rooms

THE SECOND FLOOR—ALTERNATING-CURRENT LABORATORY

The room in the northwest corner of the second floor (see Fig. 4) is the alternating-current laboratory. It has a total floor space of over 2100 square feet (38 feet by 56 feet) and includes also an instrument room, instructor's office, and the photometer rooms. This laboratory, like the direct-current laboratory on the first floor, already described, contains a number of testing beds, upon which the motors and generators may be mounted. There are six testing beds of different sizes holding from one to three machines on each. The wiring is overhead. The only direct-current machinery in this laboratory is that used for driving the generators. There is available at all parts of the laboratory current from the storage battery in the basement, the possible electromotive force of which varies from 6 volts to 150 volts. The purpose of this is, for instance, separate excitation where a very uniform current is desired. The 6-volt battery current can be supplied up to 180 amperes, and the 150-volt up to 15 amperes.

The switchboard in this room is the largest one in the building for laboratory purposes; it is over 14 feet in length and contains seven marble panels, all circuits being protected by I. T. E. circuit-breakers. The alternating-current circuit of each test is entirely separate and distinct from that of all the other tests, the source of supply being an alternator driven by a direct-current motor for that purpose alone. There is, therefore, no interference whatever between the different tests. At each testing bed there is located a rheostat for the generator supplying the machine under test, so that the man at the testing bed can readily control his electromotive force, and he has practically an isolated plant under his direction.

In this laboratory are made tests on single-phase, two-phase and three-phase generators and motors, arc lamps, experiments on transformers, the effect of capacity and reactance in different arrangements of series and multiple. There is a full supply of synchronous and induction motors and generators for tests, all prominent makers being represented. There are seven alternating-current motors, and there is other apparatus in much variety, such as two or three wave-form machines, one of which is a Rosa curve tracer. There are about 100 voltmeters, ammeters and wattmeters provided for this laboratory, the number allotted to each experiment being ample for the rapid and accurate carrying on of the test. There are, moreover, potential transformers, current transformers, frequency indicators, synchronizers, power-factor indicators, arc lamps, including Adams-Bagnall and General Electric, both alternating current and direct current. All portable apparatus is stored away in cabinets in the instrument room.

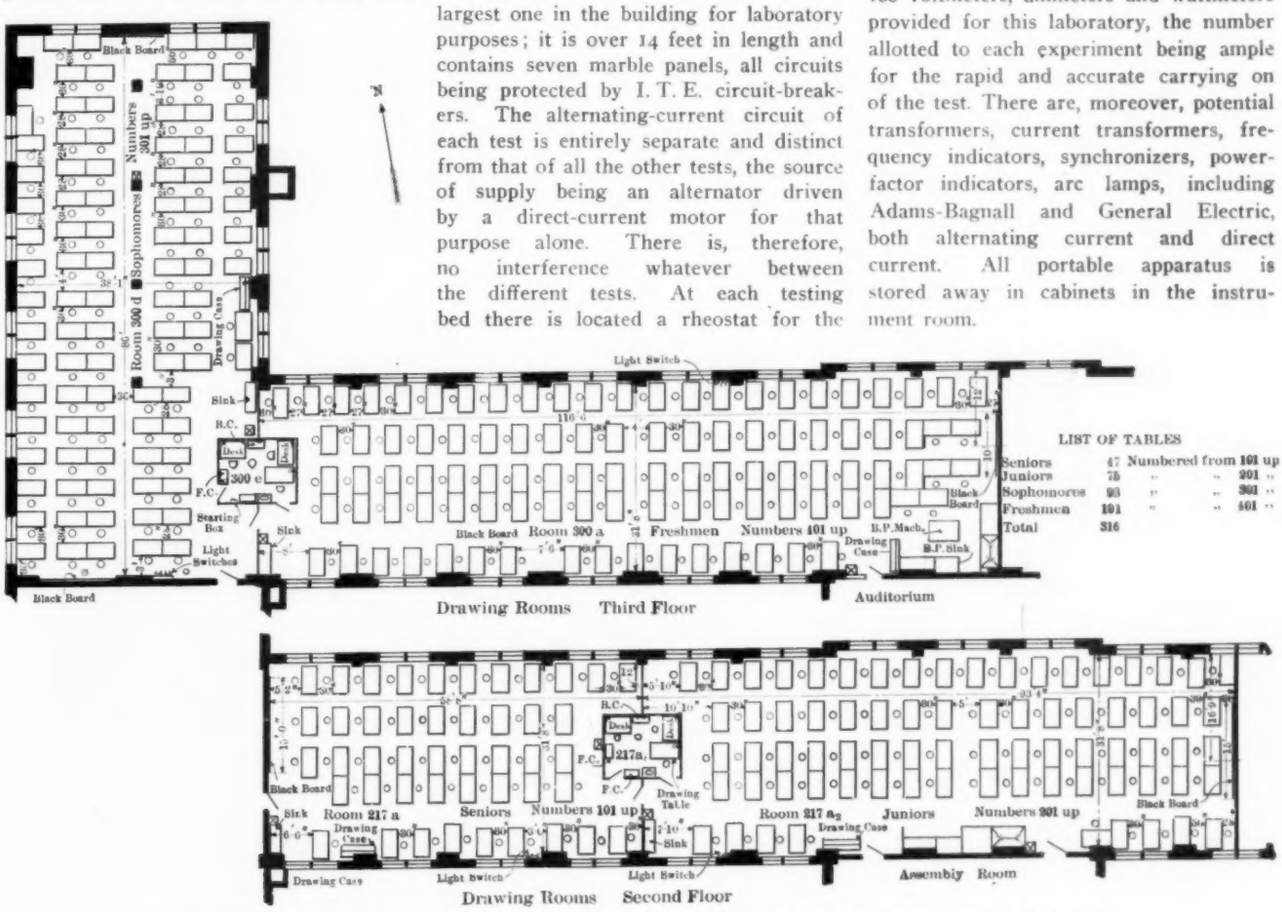


FIG. 20. PLAN OF DRAWING ROOMS AND INSTRUCTORS' OFFICES, MECHANICAL ENGINEERING DEPARTMENT

THE PHOTOMETER ROOM

At the southern end of the alternating-current laboratory are two photometer rooms, one equipped with a Bunsen photometer and the other with a Lummer-Brodhun, made by the Leeds & Northrup Company, each of which has a three-meter track. A "labyrinthic" entrance insures darkness; ducts and electric fans provide ventilation.

THE STORAGE-BATTERY ROOM IN THE BASEMENT

In connection with the electrical laboratory it is proper to speak of the storage-battery installation, which when finished will supply current to the direct- and alternating-current laboratories, and will contain 16 General Storage Battery Company cells, capable of supplying 15 amperes for eight hours, or 60 amperes for one hour; and 66 Electric Storage Battery Company cells, capable of supplying 4½ amperes for eight hours, or 18 amperes for one hour. This room is located in the basement at the southwest corner of the building (Fig. 2).

THE REPAIR SHOP ON THE SECOND FLOOR

The room next south of the alternating-current laboratory on the second floor is a repair shop, containing a complete assortment of machine tools and small tools for making repairs to the apparatus in the laboratories, and for instrument making. This work is done by toolmakers employed for the purpose, although the equipment may be used by students engaged in thesis work, or by students who require some special contrivance for use in laboratory experiments. There are about 900 square feet of floor space in the room.

THE JUNIOR AND SENIOR DRAWING ROOMS

The back portion of the second floor is occupied by the drawing rooms for the juniors and seniors (see Fig. 20), the eastern portion being for the juniors, and the western portion for the seniors; we are not now considering the civil-engineering department drawing rooms, which are in line with the former at the other end of the building. The equipment of these rooms is similar to that of the rooms for the freshmen and sophomores on the floor above, which will be described later.

ASSEMBLY ROOM, LIBRARY, ETC.

In the middle of the building on this floor is the assembly room, or "students' relaxation room," which will be fitted up comfortably for the students to use in their leisure moments.

The middle room in the front, or south of the building is the library, and above it on the third floor is a book stack communicating with the library by a winding staircase. The library and stack will hold about 20,000 volumes.

Along the front of the building on each side of the library are several recitation and lecture rooms which are continued around on the end of the building on this floor. Across the corridor on the south side of the light-wells are several rooms for the instructors.

THE THIRD FLOOR

The allotment of the space on this floor is sufficiently indicated on the plan, Fig. 5, it being only necessary to give details of the freshman and sophomore drawing rooms, which occupy the back portion.

THE FRESHMAN AND SOPHOMORE DRAWING ROOMS

The drawing rooms are shown in plan in Fig. 20. The room at the northwest corner, extending north and south, is the sophomore drawing room and is 86 feet long by 37 feet wide, and next east of it is the freshman drawing room, which is 117 feet long by 32 feet wide. The ceilings are 14 feet high. These drawing rooms, like the ones on the floor below and the laboratories, are illuminated by G. E. 110-volt 5-ampere inclosed arc lights, with opaque lower globes and concentric diffuser shades, which give an abundance of light, a very uniform distribution, without dazzling or shadow. The freshman room contains 17 arc lights, and the other rooms are in proportion. Each student has assigned to him his own drawing table, there being provision for 101 men in the freshman room and 93 in the sophomore. The drawing table and stool assigned to each student for his exclusive use throughout the college year bear the same number, and the locks on the drawer and cabinet are opened by the same combination as his locker in the basement. The standard drawing table and standard stool are shown in Figs. 21 and 22 respectively. Portable drawing boards 23x31 inches are used and kept, with the T-square, in the cabinet under the table when not in use. The numbers are not only painted, but are

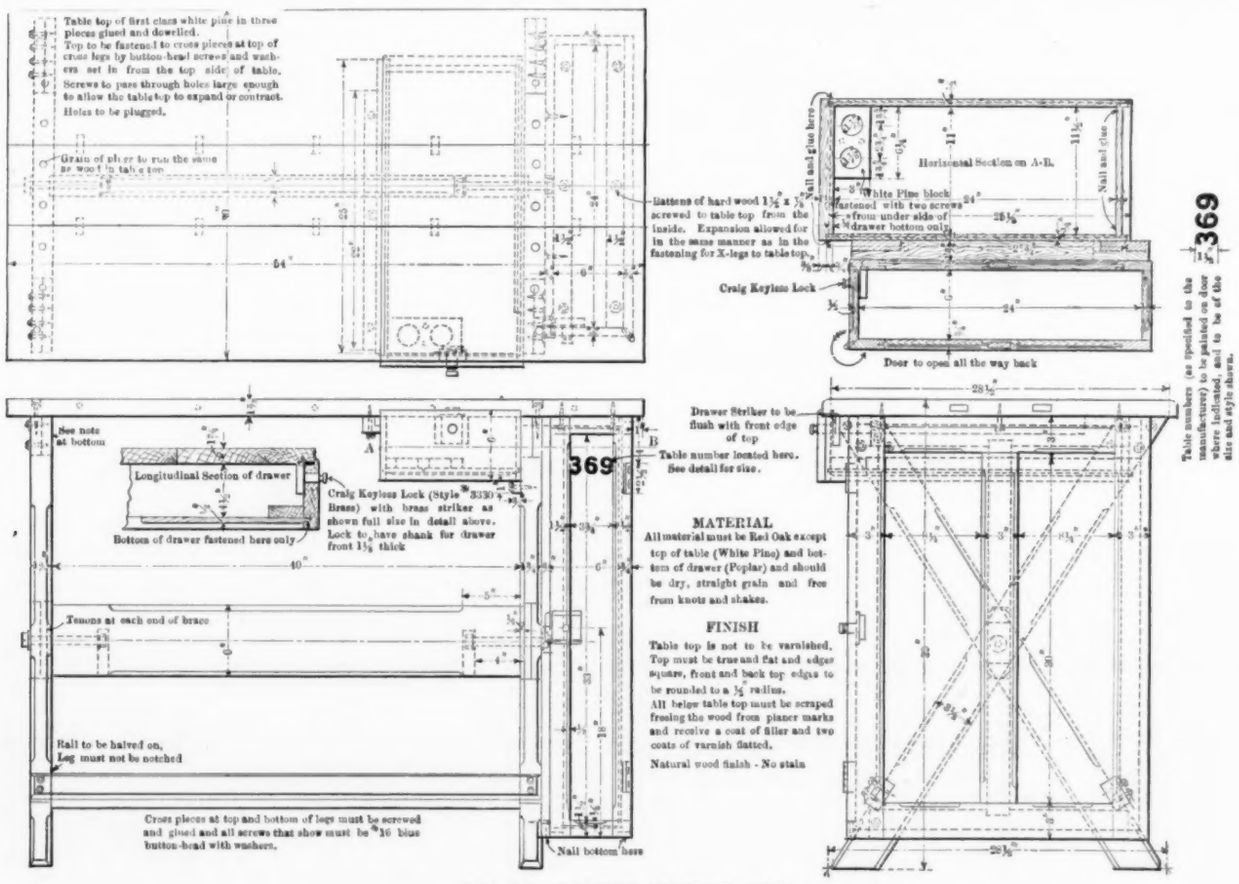


Table top of first class white pine in three pieces glued and doweled.
Top to be fastened to cross pieces at top of cross legs by button-head screws and washers set in from the top side of table.
Screws to pass through holes large enough to allow the table top to expand or contract.
Holes to be plugged.
Grain of plugs to run the same as wood in table top
Battens of hard wood 1¼ x ⅞ screwed to table top from the inside. Expansion allowed for in the same manner as in the fastening for X-legs to table top.
Horizontal Section on A-B.
White Pine block fastened with two screws from under side of drawer bottom only.
Craig Keyless Lock
Door to open all the way back
369
Table numbers (as provided by the manufacturer) to be painted on door where indicated, and to be of the size and style shown.
See note at bottom
Longitudinal Section of drawer
Craig Keyless Lock (Style 3330 Brass) with brass striker as shown full size in detail above. Lock to have shank for drawer front 1⅛ thick
Bottom of drawer fastened here only
Drawer Striker to be flush with front edge of top
Table number located here. See detail for size.
MATERIAL
All material must be Red Oak except top of table (White Pine) and bottom of drawer (Poplar) and should be dry, straight grain and free from knots and shakes.
FINISH
Table top is not to be varnished. Top must be true and flat and edges square, front and back top edges to be rounded to a ½" radius.
All below table top must be scraped freeing the wood from planer marks and receive a coat of filler and two coats of varnish flatted.
Natural wood finish - No stain
Tenons at each end of brace
Rail to be halved on. Leg must not be notched
Cross pieces at top and bottom of legs must be screwed and glued and all screws that show must be #16 blue button-head with washers.
Nail bottom here

FIG. 21. STANDARD DRAWING TABLE

impressed in intaglio on the articles, so that they cannot be changed, and the stools for any one room all have a color band around them, peculiar to that room, which at once indicates where they belong. The total floor area of the four drawing rooms in this department is 11,800 square feet.

The system of instruction in drawing is thoroughly systematized, and by means of a card index and vertical-filing system a complete record is kept of the work of each student. The first four plates of the freshman year are all alike, being merely copies, and after this the work throughout the course is individual, each man working out his own problems, as assigned by the instructors.

The building is equipped with telephone systems, so that the offices of heads of departments are connected together, and the separate branches of the different departments are also connected by separate lines.

Figs. 23 and 24 are views properly belonging to the previous instalment of this article, but the photographs did not come in time. They show the foundry and the gas engines in the mechanical laboratory. These engines, like the steam engines and other motive-power machines, are well provided with Prony brakes.

THE CIVIL-ENGINEERING DEPARTMENT—A FINE HYDRAULIC LABORATORY

As already stated, the eastern end of the building is occupied by the civil-engineering department. The most prominent feature of this portion is the hydraulic laboratory which occupies the northeast corner, and extends through three floors. The general drawing of it is given in Fig. 25, and some of the details in the basement in Fig. 26. In this laboratory there is a pressure tank 5½ feet in diameter and 37 feet high, of ⅜-inch plates, with a total capacity of 5800 gallons, shown in outline in Fig. 27, for the purpose of furnishing water for experiments on the discharge through orifices and tubes, and in connection with it are two calibrated weir tanks 5x5½ feet in cross-section, 34 feet long, with partially removable ends to permit also of observations of flow over submerged weirs and dams. They discharge into two weighing tanks on scales mounted on wheels, each having a capacity of 1800 gallons and arranged with quick-discharge valves for emptying them into the main supply tank underneath, which has a capacity of 23,000 gallons. By having two tanks, it is thus possible to have a continuous discharge. The main supply tank is connected with the city water mains, and also by overflow and drain pipes with the sewer. It is below the basement floor level, and can receive the discharge from any piece of apparatus either at the basement or at the first floor level.

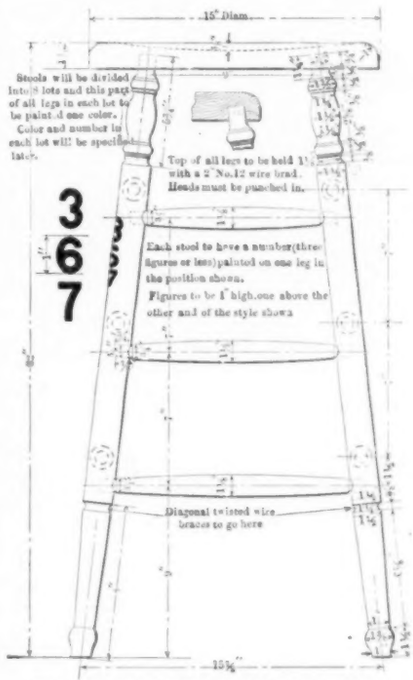

15" Diam.
Stools will be divided into 8 lots and this part of all legs in each lot to be painted one color. Color and number in each lot will be specified later.
Top of all legs to be held 1½ with a 2" No.12 wire brad. Heads must be punched in.
3
6
7
Each stool to have a number (three figures or less) painted on one leg in the position shown.
Figures to be 1" high, one above the other and of the style shown
Diagonal twisted wire braces to go here
15⅛"

FIG. 22. STANDARD STOOL FOR DRAWING ROOMS

There is an 8-inch tubular well 100 feet deep passing through the floor of this tank for experiments on the efficiency of various forms of deep-well pumps and air lifts.

The four half-tones, Figs. 28, 29, 30 and 31, give a very good idea of the hydraulic laboratory. The first mentioned is a view in the basement and shows the lower portion of the pressure tank, at the extreme bottom of which is an inlet connection, above which the tank gradually flares out until it reaches its full diameter. By this means the velocity of the water passing through the inlet valve is reduced, gradually and without agitation, to the small velocity required in the much greater cross-section of the tank. The archways at the right are entrances to the space under the weir tanks, which is used for storage. Alongside of the pressure tank, and just above the circumferential riveted joint, can be seen a supply pipe entering one of the concrete weir tanks.

Fig. 29 is a view on the floor next above, that is, the first floor. It is taken from the discharge end of the weir tanks, the gates being visible in the immediate foreground. At the far end of the left-hand tank can be seen the inlet T, through which the water enters from the connection seen in Fig. 28. This T is, on the side next the wall, perforated with numerous small holes, so as to eliminate as far as possible the disturbing effect of the current of water entering the tank. The shaft with sheaves, seen crossing the tanks, is for lifting valves in the bottom for emptying them; this arrangement was not completely rigged up at the time the picture was taken.

The weir tank is also used to receive the discharge from orifices, one of which may be plainly seen in the pressure tank.

Fig. 30 is a view showing the upper end of the pressure tank in room 216 on the second floor.

In Fig. 31 at the upper left-hand corner can be seen a small portion of the chutes which regulate the discharge into the weighing tanks of the water received from the weir tanks. One of the latter is also visible in the illustration.

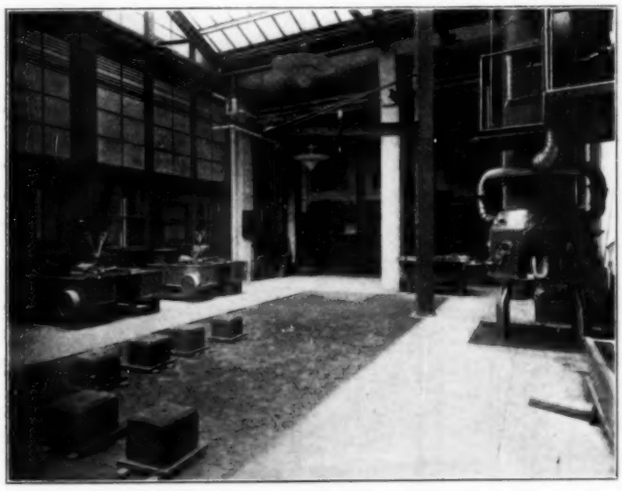


FIG. 23. FOUNDRY

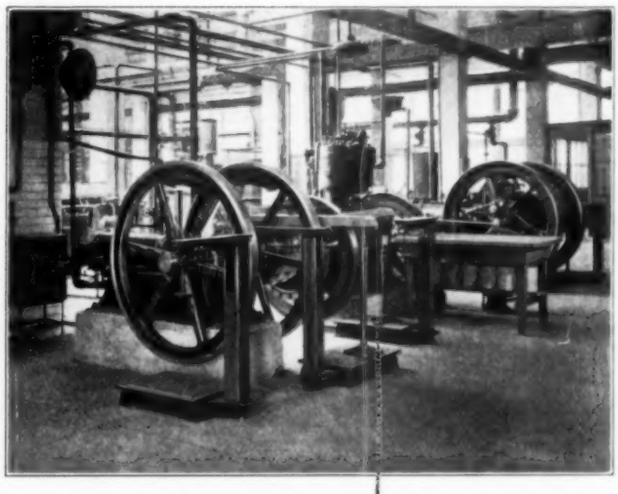


FIG. 24. A CORNER IN THE MECHANICAL LABORATORY. THE GAS ENGINES

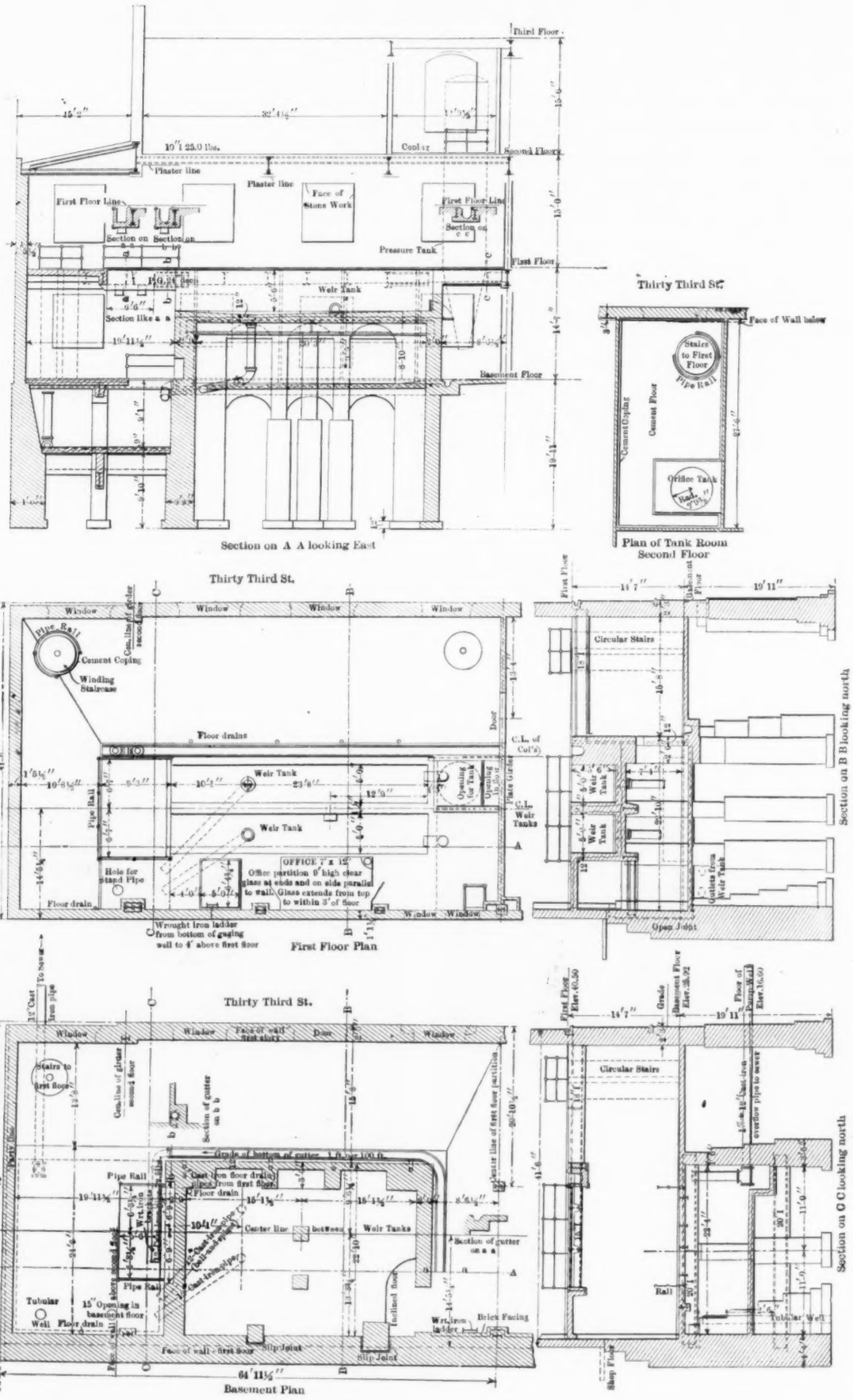


FIG. 25. HYDRAULIC LABORATORY, GENERAL DRAWING

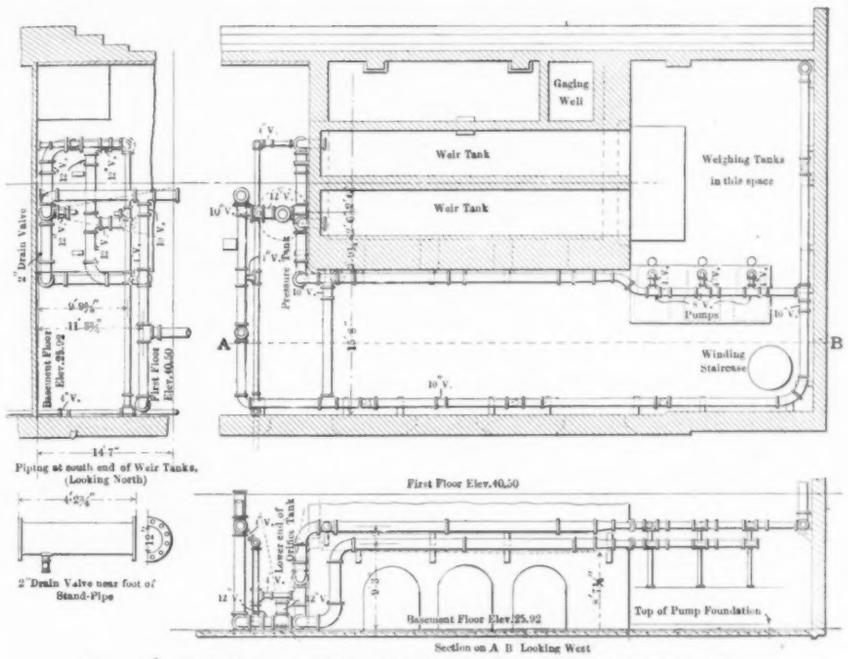


FIG. 26. BASEMENT PORTION OF HYDRAULIC LABORATORY AND PIPING

The pumping plant consists of three centrifugal pumps, indicated in Fig. 26, and plainly shown in Fig. 31, direct driven by variable-speed motors, which can be operated either separately or combined and at various speeds. The switches and controlling apparatus can be seen mounted on the wall at the right of Fig. 31.

A 12-inch stand-pipe is provided extending from the basement to a hight of about 65 feet or a little above the main roof, being 50 feet above the main working floor. This pipe is shown in Fig. 27 and is offset just below the third floor, as shown in Fig. 30, in order to avoid making an obstruction in the room above. Extending through the hydraulic laboratory are pipes with numerous connections to supply water to various pieces of apparatus as desired.

As can be seen from the plans, the pressure tank extends up through the first and second floors, and it is provided in the room on the second floor (Fig. 30) with additional orifices similar to those down below at the first floor (Fig. 29). These orifices and their fixtures are of quite interesting design, being so made that they can be changed with pressure on the tank without having to discharge the contents. As such a change will, in the course of the experiments, have to be frequently made, there is therefore a great saving of time and power because it is unnecessary to empty and refill the tank. The device is shown in Fig. 32, Fig. 33 showing most of the details of it and also the orifice plates M themselves, which are 14 in number and have round, square and triangular orifices of various sizes, from 0.05 foot to 0.4 foot diameter. The outside of the orifice plate is threaded 12 per inch and screws into the orifice holder N, so that its face is flush with the inner end of the latter. The orifice holder has a short triple thread, 3 inches pitch, on its outer surface and is screwed into the main casting P with a special spanner T. To serve as a nut there are pins $S\,S\,S$, Fig. 32, which engage with the three short screw-threads on N. A stuffing box outside of the orifice holder provides against leakage. Inside the tank, set in the inner face of the main casting P, is a disk or rotating gate Q with a stem projecting through another stuffing box to the outside, to permit of its being turned to either shut off the water from the orifice or to bring an opening R in the disk opposite the orifice. When the gate is closed, the holder is set up tight against its scraped surface, making a joint practically watertight and permitting the insertion of the orifice plate into the holder. The holder must be slacked back slightly in order to permit of opening the gate. This accomplished (the orifice plate of course now being in the holder), the holder is screwed in farther by means of the spanner T (which does not interfere with the outflow of water), so that it projects through the opening in the gate. The design is such that when set up as just described a very smooth surface is presented to the flow of the water, so as to avoid any obstructions interfering with the formation of the jet.

This orifice device was designed by William Easby, Jr., assistant professor of civil engineering. A device used at McGill University suggested the circular rotating gate. The parts are made of bronze.

Next south of the hydraulic laboratory in the basement are small laboratories, repair shop, geodetic laboratory and room for surveying instruments (Fig. 2).

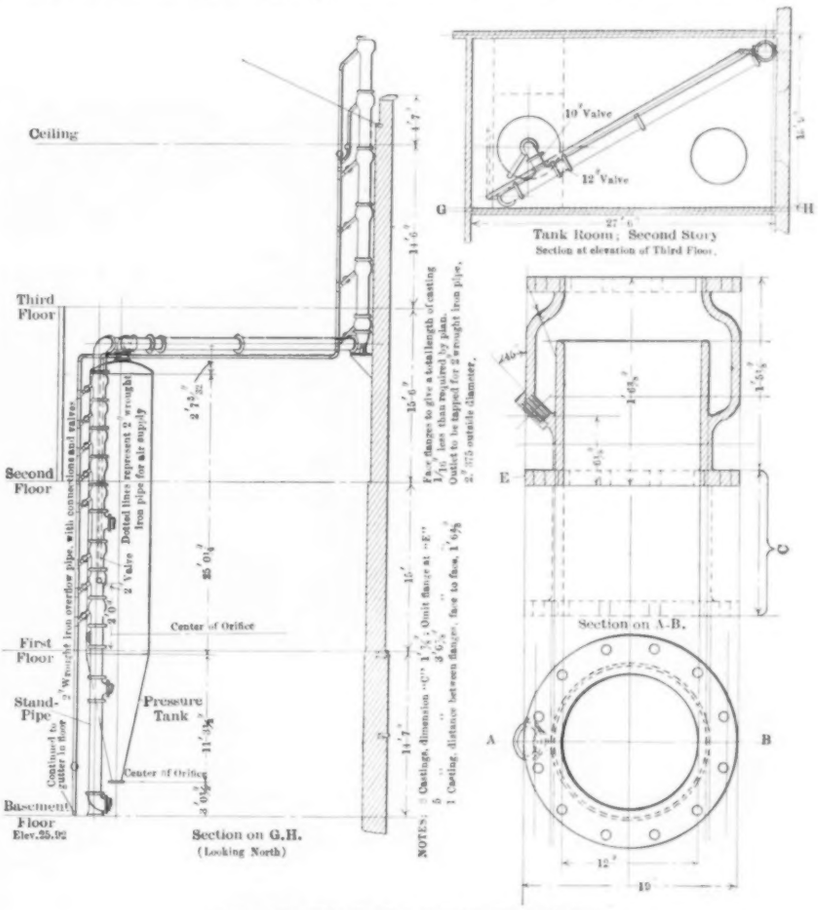


FIG. 27. STAND-PIPE AND PRESSURE TANK

On the first floor south of the hydraulic laboratory is the testing laboratory of the civil-engineering department, which contains the principal material-testing machines. In this laboratory, of which a plan is given in Fig. 34, and a view of part of it in Fig. 35, are several universal testing machines of various types, ranging in capacity from 30,000 to 200,000 pounds, besides machines for special forms of tests, and foundations are being prepared for an immense vertical testing machine of 600,000 pounds capacity, which will be set in the basement and extend up through the first floor.

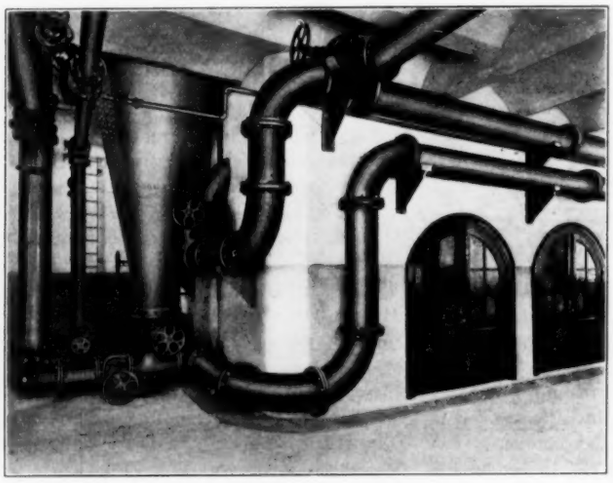


FIG. 28. CONICAL BOTTOM SECTION OF PRESSURE TANK; STAND-PIPE AND PIPING SYSTEM, AND BASEMENT OF HYDRAULIC LABORATORY

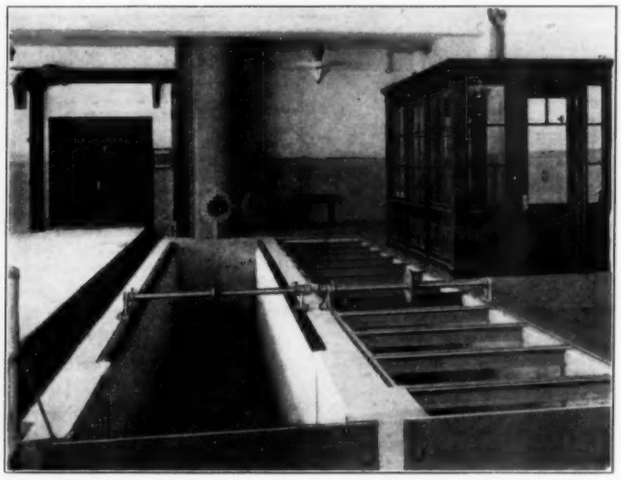


FIG. 29. WEIR TANKS AND PRESSURE TANK. HYDRAULIC LABORATORY, FIRST FLOOR

The room at the southeast corner on the first floor is a very completely fitted up laboratory for testing of cement, mortars and concrete, containing testing machines of various types for tensile, compressive and bending tests, a briquet-making machine, immersion tanks, damp-closets, etc., and a number of individual work tables, each completely equipped with an outfit of minor apparatus. Fig. 36 is a view in this laboratory. Special provision is made for investigating the properties of plain and reinforced concrete. In Fig. 37 is shown a crane made for carrying concrete beams, and a large immersion tank. When the beam is ready to test it can be carried to the testing machine by the use of this crane, which is provided with wheels or casters.

The other rooms of the civil-engineering department are sufficiently indicated on the floor plans. The drawing rooms are similar in arrangement to those at the western end, although smaller, and the standard drawing table of this department differs only in detail from that of the mechanical-engineering department shown in Fig. 21. H. J. K.

With a view to reducing the great quantity of smoke around Pittsburg, a locomotive on the Pennsylvania railroad is being experimentally equipped with a device for burning pulverized bituminous coal.

Shifting-Belt Planer Drive

BY E. H. WARING

W. H. Henley's most interestng article at page 310 entitled "An Improved Planer Drive" probably gave food for thought to many who have for years considered that the shifting-belt drive long ago reached its highest point of development. Apparently, however, it can still be improved in most cases.

As the AMERICAN MACHINIST has repeatedly pointed out in recent years it is the pulleys, and not the table, that are responsible for the difficulties experienced at reversal with modern high-speed planers of large size, but it remained for Mr. Henley to show this in a concrete example that must be most convincing to all readers.

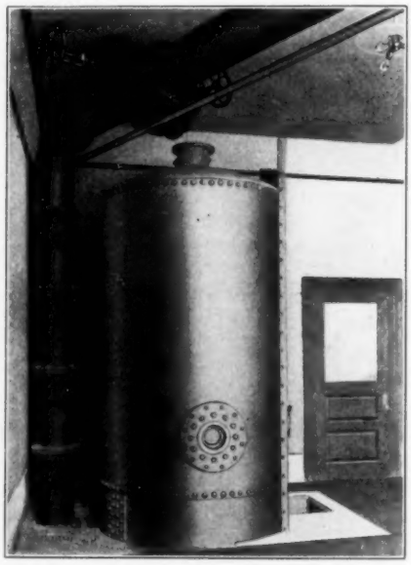


FIG. 30. STAND-PIPE AND UPPER END OF PRESSURE TANK, SECOND FLOOR

AN INVESTIGATION OF THE SUBJECT

A number of years ago the Crocker-Wheeler Company, having made a specialty of the motor equipment of machine tools, found it necessary to investigate this subject thoroughly. The problem is of importance because the rapid reversal of the moving parts of planers, etc., using the shifting-belt drives causes great fluctuation of the load on the motor, so much so in fact, that in the great majority of cases it is the peak load that will occur at reversal that determines the size of motor that must be used, unless the belt drive be specially designed. As a result of this investigation, while agreeing in general with the conclusions reached by Mr. Henley, I would like to make a few comments on his article and suggest still another way of attaining the same object.

THE USE OF STEEL PULLEYS

Mr. Henley's idea as described is to reduce the amount of energy that must be wasted in heat at each reversal by employing a special and rather complicated drive that reduces the energy of tight pulleys on the driving shaft about 36 per cent. and the total reverse energy about 28 per cent. A simpler way that is in most cases mechanically practicable is to use pulleys having a rim thickness of 1/16 instead of ¼ inch, in other words, pressed-steel pulleys. This will greatly reduce the pulley energy, as the rim energy is proportional to the weight multiplied by the square of the velocity, and this change can usually be made on any standard design of planer at slight expense.

A DANGER TO BE AVOIDED

Caution should be exercised in making this change, or the experimenter may find that he has reduced the energy too much, so that the table is stopped by the return belt before the dog has moved the rocker far enough to completely shift the belt on to the return pulley. This gives rise to another problem that is hard to solve satisfactorily on very large machines

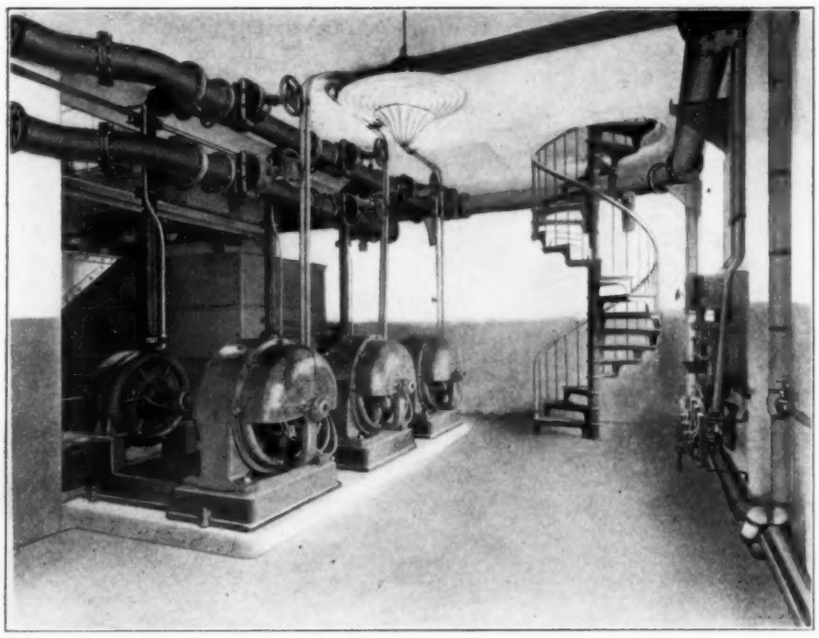


FIG. 31. TWO-STAGE ELECTRICALLY DRIVEN CENTRIFUGAL PUMPS; OVERHEAD CHUTES AND WEIGHING TANKS. BASEMENT, HYDRAULIC LABORATORY

especially where a wide range of cutting speeds is employed. Also not all makes of pressed-steel pulleys will stand the severe duty imposed upon them unless they are made slightly special.

SOME ACTUAL CASES

Returning to Mr. Henley's drive there are several changes that would improve its durability and efficiency. Take for instance the case described in column 2 and shown in Fig. 1. Suppose that instead of troublesome noisy idler gears modern high-speed silent chain be employed and that the construction be changed so that the upper pulley B for the cutting belt be slightly smaller than the return pulley A. This would, of course, require that the cutting belt be crossed and that its pulley B be below A, a construction already used by some of our manufacturers.

Let us assume for simplicity that the return ratio is 2 to 1 as it is not stated what this ratio actually is. As in the modified design suggested above the cutting belt is crossed, the arc of contact will be approximately 210 degrees and for the same maximum belt stress the effective pull at the pulley rim will be according to Nagle's experiments about 7 per cent. more than for the open belt in Case 2. Or, for the same torque on the driving shaft, the pulley should be reduced to 33.65 inches. In other words the cutting belt if crossed and used on a pulley 6½ per cent. smaller would have the same pulling capacity, and the basis of comparison is a fair one. Except for these changes the rest of the drive, including the gearing, is identical in each case.

Energy is proportional to Wv^2 and as both rim and arm weight and rim velocity are reduced 6½ per cent., the total pulley energy is 81.5 per cent. of that in the case where a 36-inch pulley is used. Therefore, with nothing sacrificed, there is a considerable reduction in energy.

The objection may be raised by some that this reduction of pulley diameter will reduce the slipping torque of the return belt and that the time required to reverse will not be reduced, even though the waste energy is diminished 18½ per cent. The slipping pull of a belt at 2010 feet a minute on the small pulley will, for the same stress, be slightly more than

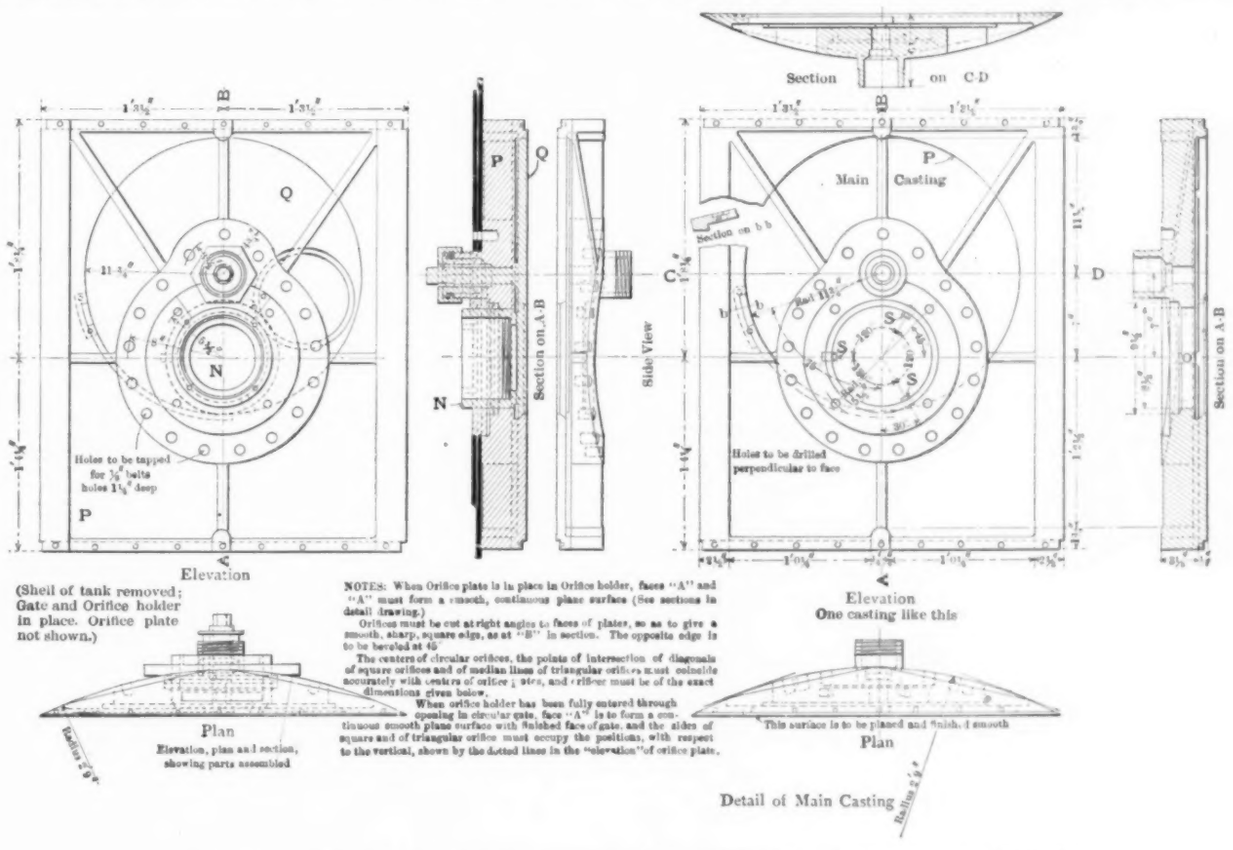

Section on C-D
Main Casting
Holes to be tapped for ⅜" belts holes 1½" deep
Holes to be drilled perpendicular to face
Side View
Section on A-B
Elevation
(Sheil of tank removed; Gate and Orifice holder in place. Orifice plate not shown.)
Plan
Elevation, plan and section, showing parts assembled
NOTES: When Orifice plate is in place in Orifice holder, faces "A" and "A" must form a smooth, continuous plane surface (See sections in detail drawing.)
Orifices must be cut at right angles to faces of plates, so as to give a smooth, sharp, square edge, as at "B" in section. The opposite edge is to be beveled at 45°
The centers of circular orifices, the points of intersection of diagonals of square orifices and of median lines of triangular orifices must coincide accurately with centers of orifice plates, and orifices must be of the exact dimensions given below.
When orifice holder has been fully entered through opening in circular gate, face "A" is to form a continuous smooth plane surface with finished face of gate, and the sides of square and of triangular orifice must occupy the positions, with respect to the vertical, shown by the dotted lines in the "elevation" of orifice plate.
Elevation
One casting like this
This surface is to be planed and finished smooth
Plan
Detail of Main Casting

FIG. 32. DEVICE FOR HOLDING ORIFICES AND CHANGING THEM WITH TANK UNDER PRESSURE

on a 36-inch pulley at 2150 feet per minute, because of the lesser effect of centrifugal force, but let us assume the same pull in each case.

It can be shown that the time required to retard and accelerate the moving parts at reversal from the cutting to the return stroke is approximately proportional to

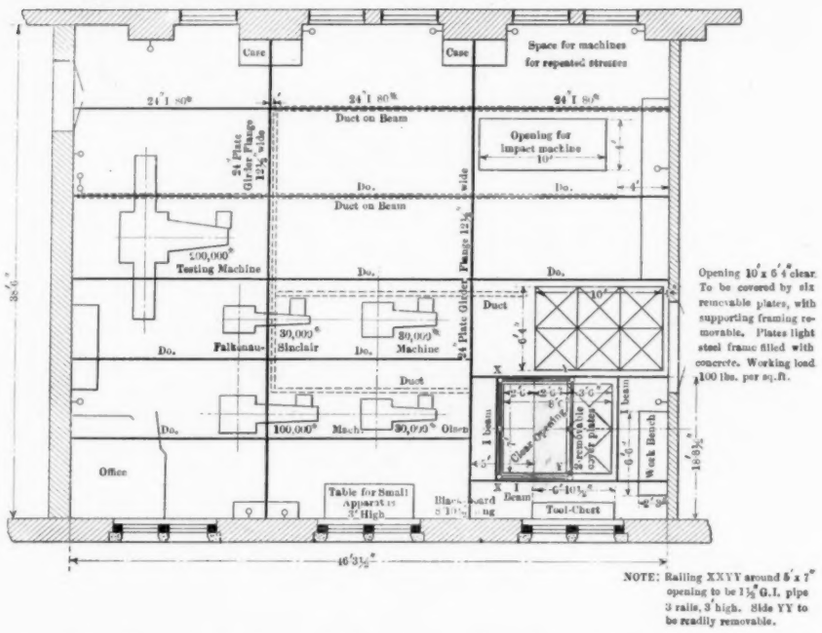
$$\frac{2(1+x)E_r}{x f v_r},$$

if the energy only is considered. As a matter of fact the friction of bearings, etc., helps the belt in retardation, but correspondingly reduces the accelerating force. Practically, however, the total time of reversal is not materially changed, whether friction is or is not considered in the calculations. In the above expression E_r = energy in moving parts during return stroke f = slipping pull of return belt in pounds at rim of pulley, v_r = velocity in feet per second of return pulley rim during return stroke, x = ratio of return to cutting speed.

In Case 2, E = 8030 foot pounds and assuming a 300-pound belt pull we have

$$t = \frac{2 \times 3 \times 8030}{2 \times 300 \times 71.7} = 1.12 \text{ seconds.}$$

Using the 33.65-inch diameter pulley


Case
Case
Space for machines for repeated stresses
24" I 80#
Duct on Beam
Opening for impact machine
Do.
Testing Machine
Falkenau-
Sinclair
Machine
Duct
Office
Table for Small Apparatus 3' High
Work Bench
Tool-Chest
Opening 10' x 5' 4" clear. To be covered by six removable plates, with supporting framing removable. Plates light steel frame filled with concrete. Working load 100 lbs. per sq. ft.
NOTE: Railing XXYY around 5' x 7' opening to be 1½" G.I. pipe 3 rails, 3' high. Side YY to be readily removable.

[Note:—Since the above drawing was made, the following machines have been placed in the vacant spaces: 15,000-lb. wire tester, torsion machine, bending machines, cold-bend machine, pendulum torsion machine.]

FIG. 34. ARRANGEMENT OF TESTING MACHINES, ROOM 102

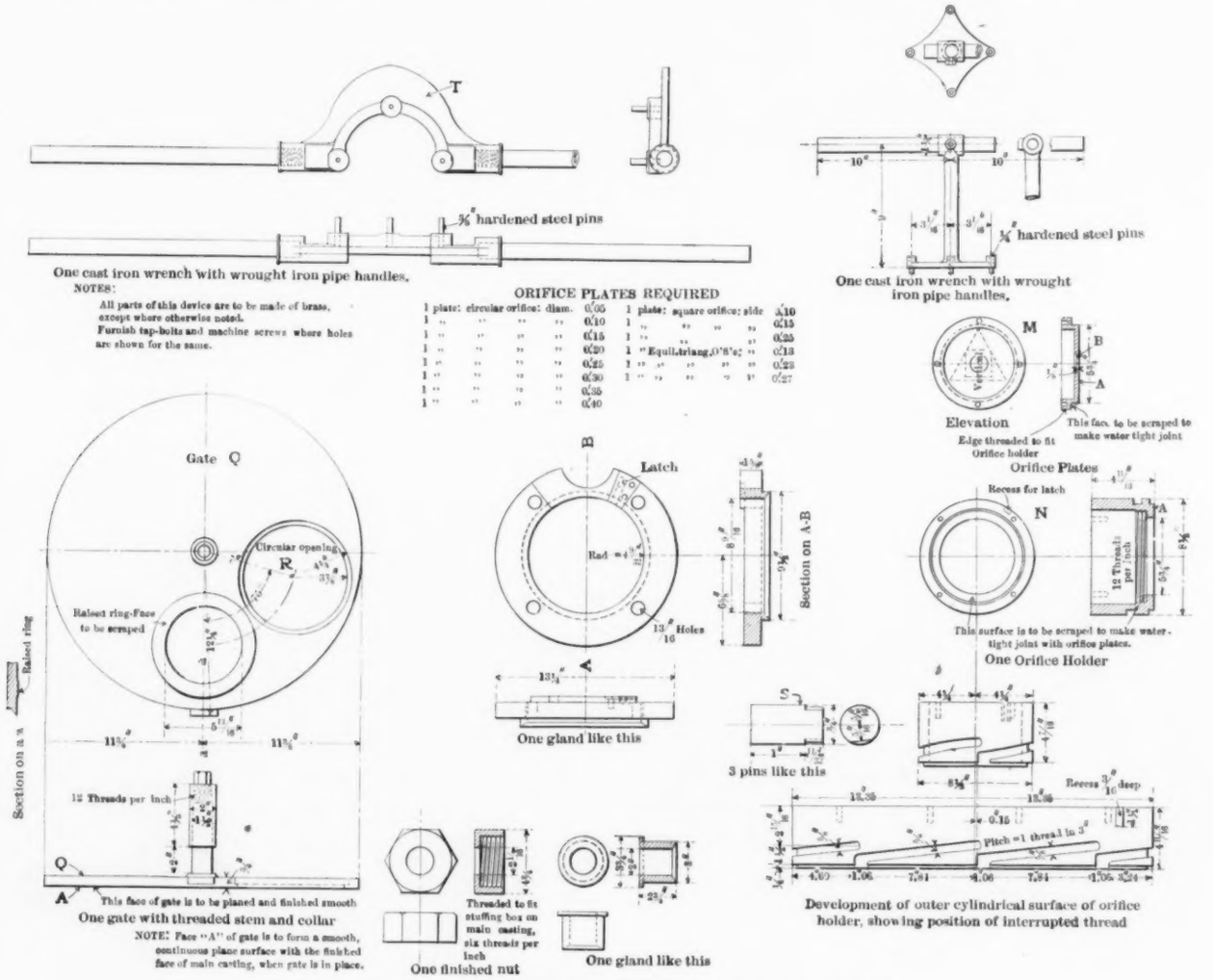

T
⅜" hardened steel pins
One cast iron wrench with wrought iron pipe handles.
NOTES:
All parts of this device are to be made of brass, except where otherwise noted.
Furnish tap-bolts and machine screws where holes are shown for the same.
ORIFICE PLATES REQUIRED
1 plate: circular orifice: diam. 0.05
1 " " " " 0.10
1 " " " " 0.15
1 " " " " 0.20
1 " " " " 0.25
1 " " " " 0.30
1 " " " " 0.35
1 " " " " 0.40
1 plate: square orifice; side 0.10
1 " " " " 0.15
1 " " " " 0.25
1 " Equil. triang. 0' 8" sides 0.13
1 " " " " 0.23
1 " " " " 0.27
Gate Q
Circular opening
Raised ring-face to be scraped
Raised ring
Section on a a
12 Threads per inch
This face of gate is to be planed and finished smooth
One gate with threaded stem and collar
NOTE: Face "A" of gate is to form a smooth, continuous plane surface with the finished face of main casting, when gate is in place.
Latch
Rad = 4"
13/16" Holes
Section on A-B
One gland like this
Threaded to fit stuffing box on main casting, six threads per inch
One finished nut
One gland like this
Elevation
Edge threaded to fit Orifice holder
This face to be scraped to make water tight joint
Orifice Plates
Recess for latch
12 Threads per inch
This surface is to be scraped to make water-tight joint with orifice plates.
One Orifice Holder
3 pins like this
Recess 3/16" deep
Pitch = 1 thread in 3"
Development of outer cylindrical surface of orifice holder, showing position of interrupted thread

FIG. 33. DETAILS OF ORIFICES AND DEVICE FOR HOLDING THEM

with crossed cutting belt, the rim and arm energy is reduced as shown above 18½ per cent. or to 4520 foot pounds. Adding to this the 780 for table and 1700 for gearing, we have 7000 foot pounds total. v_r is now 67 feet per second and, for the same belt pull, the time is

$$t = \frac{2 \times 3 \times 7000}{2 \times 300 \times 67} = 1.04$$

seconds. In other words, there is less work to be done at reversal and the time of reversal is reduced 7 per cent. As a result the belts will last longer and the operation of the planer will be more satisfactory. Most of the planer manufacturers have discovered this, and now standard practice is to cross the cutting belt.

In column four the same planer having the usual type of driving-shaft pulley construction, one 36 inches and one 27 inches diameter, is compared with the up-to-date planer of 1904, having both cutting and return belt pulleys 36 inches in diameter, as described in column one. In justice to the usual design it should be said that the basis of comparison does not seem to be a fair one, for, again assuming a 2 to 1 return, the speed of the cutting belt is 2630 feet per minute compared with only 2150 feet per minute for the planer having both pulleys 36 inches diameter.

A CONCLUSION CRITICIZED

As is well known, pulling capacity is one of the important things that is striven for in planer design, and yet the belt speed must not be too high or the waste of energy at reversals will be extreme. This is indicated by Mr. Henley, for in comparing a design having a low cutting belt speed with one having a higher speed, he widened the belt so that both would have practically the same pulling capacity, or "driving power," as he expresses it. Unfortunately he apparently forgot this important item when working out the design in column four. A true comparison of Cases 1 and 4 is as follows: Let the cutting-belt speed be 2150 feet per minute in each case and the return-belt speeds will be 4300 and 3220 feet per minute respectively. Here in Case 1 the time of reversal with a slipping belt pull of $300 \times 1.07 = 321$ pounds is

$$\frac{2 \times 3 \times 11{,}164}{2 \times 321 \times 71.7} = 1.46 \text{ seconds.}$$

In the other case Mr. Henley states that the pulley energy at 557 revolutions per minute, is 11,400 foot pounds. Then at 456 revolutions per minute, which with the same gearing as in Case 1 will give 100 feet per minute, it is

$$\frac{11{,}400 \times 456^2}{557^2} = 7640$$

foot pounds, or total energy $E_r = 7640 + 780 + 1700 = 10{,}120$ foot pounds.

$$v_r = \frac{3220}{60} = 53.7$$

feet per second, or time to reverse is

$$\frac{2 \times 3 \times 10{,}120}{2 \times 321 \times 53.7} = 1.76$$

seconds. In other words, with this design the reverse energy and wear on belts is 9 per cent. less instead of 24 per cent. more than in Case 1. To offset this, the time of reversal is apparently 21 per cent. greater, but this would actually be less than this amount, due to the fact that because of the lower belt speed the centrifugal force effect would be less and hence for the same maximum stress on the tight or driving side of the belt the slipping pull of the belt would be more than the 321 pounds assumed, which would reduce the time proportionately.

In the above the energy of the 36 and 27x5¼-inch stepped pulley has been taken as given by Mr. Henley, but for the same thickness of rim and size of arms as used in the 36x10½-inch pulley the

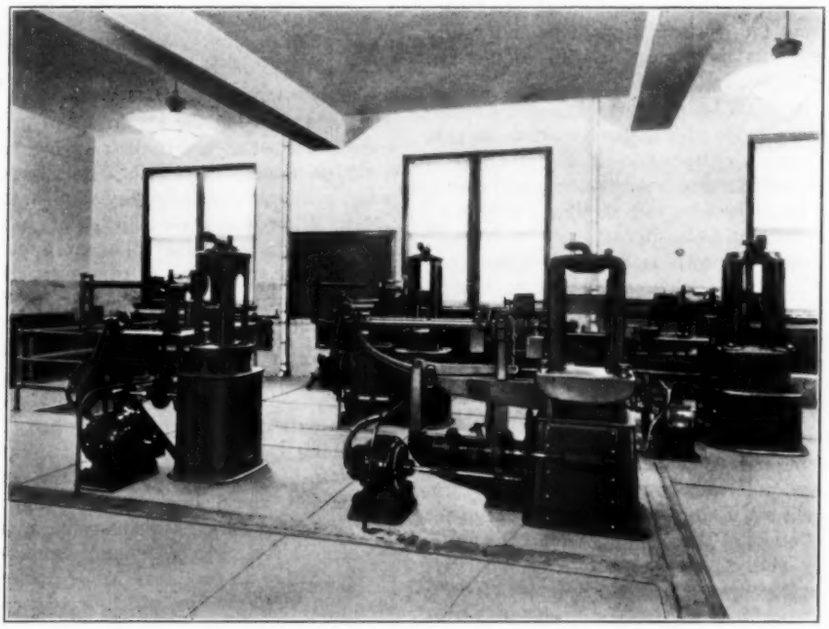


FIG. 35. UNIVERSAL TESTING MACHINES OF CAPACITY FROM 30,000 LBS. TO 100,000 LBS. IN MATERIAL-TESTING LABORATORY OF C. E. DEPARTMENT

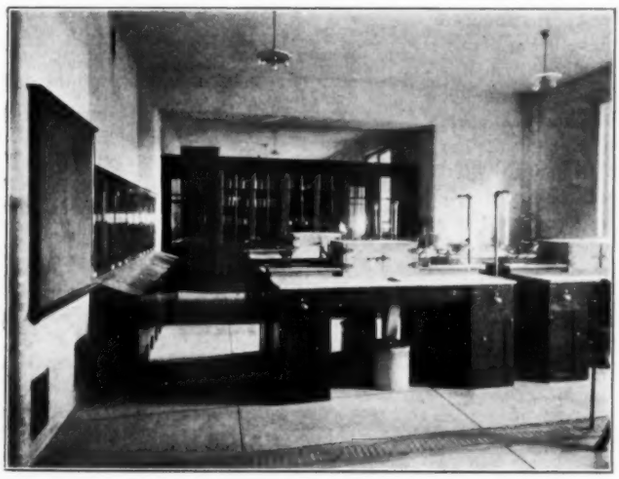


FIG. 36. BINS AND MIXING TABLES, LESLEY CEMENT LABORATORY

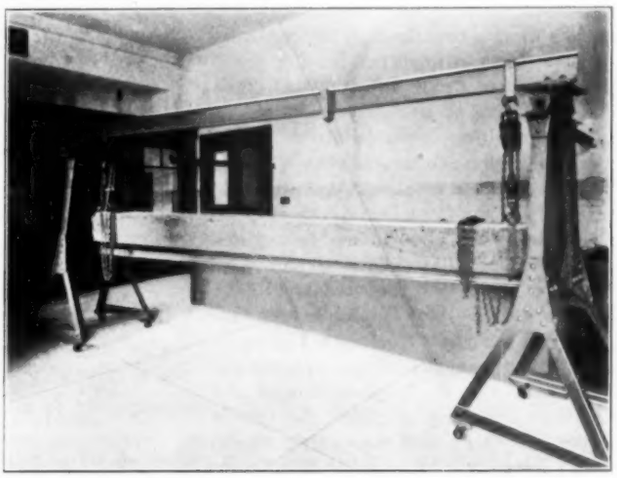


FIG. 37. CONCRETE-BEAM CRANE AND LARGE IMMERSION TANK, IN LESLEY CEMENT LABORATORY

energy of the stepped pulley should be about 6770 foot pounds instead of 7640 foot pounds, as obtained above from Case 4, or a total of 9250 foot pounds. Also the belt pull for the same maximum allowable stress on the tight side would be about 9 per cent. greater. Using these figures the saving in energy at reversal is 17 per cent and the increase in time 1 per cent. Therefore, as the time is practically the same and the energy wasted is 17 per cent. less, this type of drive is in this case to be preferred.

This advantage is even more pronounced where higher belt speeds are used, which is generally the case with large planers intended for high-speed work.

These deductions are borne out in practice, for years of evolution and experience show that in general it is advisable to have the return pulley smaller than the cutting and thus strike a happy medium between the conflicting factors, time of reversal and waste of energy.

Recent Advances in Steam Turbines—Turbine Blowers

In a paper recently presented at a meeting of the British Association for the Advancement of Science, by Gerald Stoney, on the subject of "Recent Advances in Steam Turbines—Land and Marine," the author described the development of the steam turbine for driving rotary air compressors of the turbine type, which are being used largely for blowing blast furnaces. The advantages gained are light weight, small foundation, small consumption of oil and above all, high economy of steam over the reciprocating types of blowing engines. The outfits described are generally for about 20,000 cubic feet of free air per minute, and a pressure of ten to fifteen pounds per square inch. A slightly different type is made for about 30,000 cubic feet per minute, at about one pound per square inch pressure. These blowing equipments are being used in several large iron works for dealing with the waste gases from furnaces and for driving these gases through the recovering plant, etc., an important feature being that they do not clog with tar and other matters. Since it is nearly imposible to use low-pressure steam at about atmospheric pressure economically in a reciprocating engine, the exhaust steam turbine becomes an important factor in those cases where there are non-condensing engines and other sources of exhaust steam. The American rights for the manufacture of Parsons turbine blowers have been secured by the Allis-Chalmers Company, of Milwaukee, and through an arrangement made with the English builders, the American Company will have the benefit of the experience and data of the European experts.

Roofing shingles, one-half inch thick, are now being made of reinforced concrete.

ENGINEERING INDUSTRIES IN RUSSIA—II

Wages and Expenses Low — Inadequate Equipment — Workshop Conditions Unsettled — Relations of Employer and Workmen

BY CHARLES PRESCOTT FULLER

While today and for some time to come the eyes of the whole world are and will be upon Russia and the hopes and misfortunes of her population, possibly it will interest readers of the AMERICAN MACHINIST to learn a few particulars about the workers, workshops and future prospects in connection with engineering industries in Russia.

It would be, of course, impossible within the scope of a magazine article to give a complete exposition of all pertaining to the engineering business within the confines of such a vast territory as that of Russia, or even of that part of it more generally known as European Russia.

Neither is it intended here to discuss the political outlook in Russia further than where it has a direct bearing on engineering undertakings and the attitude of the workers therein, the intention being to give a general survey of engineering practice and the difficulties contended with in it as affecting employers, workmen, and commercial interests. Government establishments may be left out of the question, as the conditions therein of supply and demand of orders or labor are necessarily on quite a different footing than with ordinary commercial undertakings, whether of the company order or run by individuals.

Up to the present time, and doubtless this will hold good for some few years to come, Russia cannot be considered as a commercial country in connection with her manufactures, in the same way as are America, Germany, or Great Britain; and in relation to engineering industries this is specially so, as the vast majority of raw and finished goods produced in her industries are manufactured or produced for home consumption, there being practically no export trade further than for the semi-civilized countries lying on her Asiatic frontiers, and even those exports with respect to the whole bulk of her manufacture are so small in quantity that they may be disregarded, being chiefly soft stuffs with a limited amount of bar iron and low-class hardware. There are occasional small consignments of ore, pig iron and bars to the west, but nothing that can be regarded as a competing trade in engineering products. In time this will probably be changed, but not just yet.

INCEPTION OF ENGINEERING ENTERPRISE

Engineering enterprise, which seriously commenced in Russia in the latter half of last century on the initiative chiefly of foreigners, for the most part British or German, took root in many districts, naturally those in the neighborhood of which ore, flux and coal abounded, or at the seaports to which they could be easily brought by sea from abroad. The pioneers in these enterprises were in many instances men who had come out to Russia in charge of machinery for mills, arsenals, dockyards, etc., who, having remained in the country a few years at good salaries, and grasping the opportunities presented, decided to invest their savings in works on their own account, some large, some smaller, as their capital and associations allowed; and the majority of these men, being practical and full of energy and with the common sense to supply exactly the classes of goods adapted to the needs of the country as they found it, went ahead, gradually increasing their works out of profits, as the needs of their neighborhood expanded, until today the greater part of such works have become flourishing companies, with ever increasing staff of workmen, profits and influence. A sharp line must be drawn between such works, which at the commencement started on sound business lines and have so continued to the present day, and those works which have been established in Russia within the past fifteen years or so, the majority of which it must be regretfully admitted are more or less in financial difficulties. The reason for this distinction will be obvious, when it is borne in mind that whereas the old established firms and works commenced in a small way comparatively, increasing their plant and staff just in proportion as the demand for their goods increased, many of the more recent concerns must needs start in a grandiose manner, each trying to outdo its predecessors in size, comprehensiveness and influence, relying much on governmental promises of support, with any amount of confidence in a very problematical future; and with an absolute absence of business foresight into that future, they put down the bulk of their capital for bricks and mortar, machinery and plant, commissions and expenses, until when they commenced to manufacture they had a minimum of working capital at command. In addition to this, they have been managed by people knowing nothing of the language or manner of handling business here and have in consequence been the victims of robbery and jobbery without limit, until today when they have gained such bitter experience, the men at present in charge and who do know something of what is needed here are at their wits' end to know

where to get the money necessary for wages each pay day, all of which by the exercise of ordinary business acumen and some common sense, at the commencement, might have been avoided.

It is impossible to follow this part of the subject further here; it is introduced to show why some plants pay and some do not and to combat the general idea that it is a bad business to commence new engineering concerns in Russia, which is very far from being the case. The country is immense, and its needs are ever increasing, but there is a right and a wrong way of doing things and naturally if people persist in commencing wrong and follow it up, they will find it not only immensely difficult to get into the right path afterward, but even if they accomplish this, they will have years of financial trouble in store.

EARLY AGRICULTURAL MACHINERY ESTABLISHMENTS AND JOB SHOPS

Russia is even today almost a purely agricultural country, and quite 75 per cent. of the whole immense population of about 150,000,000 souls are dependent on agriculture in some way or other and naturally the engineering concerns which are devoted to the manufacture of agricultural machinery and implements are the oldest established; they stand upon the soundest commercial and financial foundations and pay continuously fair dividends on capital invested in them.

These agricultural machinery workshops, and jobbing shops too, have been in the past and to a large extent remain the cradle and school for Russian working mechanics. In the light of modern engineering science, with its ever increasingly high standard of design and general workmanship and its microscopic accuracy of detail and finish in workshop processes, as practised abroad, it can hardly be regarded as wonderful that Russian mechanics are woefully deficient, as a general body, in accuracy of workmanship, or that they fail to grasp even the meaning of accuracy as needed today in connection with the construction of first-class machinery, such as engines or machine tools; and this very fact is a serious handicap to new enterprises.

The concerns that commenced years ago in a small way were in many cases started by men who were not engineers or even mechanics, but they found they had struck on a good thing and meant to work it for all it was worth. This they did, enriching themselves, but with poor results toward making fine workmen. It was hurry skurry often night and day to get out work; somehow, anyhow, only get plenty of it out. No one at that time, not even the buyers and users of machinery, cared a rap as to the *quality* of the product; so long as a reaper tore the corn down or up by the roots and scrambled through the harvest without going utterly to smash, or a thresher and gear lasted the season, or a plow dragged out a furrow without doubling up, it was sufficient; no one grumbled and all were satisfied.

A PERIOD OF IGNORANCE AND ABUSE

Under such conditions too and the high import duties on tools, the very cheapest of rubbish in machine plant was put in; no one knew the difference between a handy and a clumsy tool, or between a true spindle and an imperfect one and nobody cared. So long as a shaft could be turned near enough to run freely in a bearing it was sufficient; if holes were over size or bored 1/32 inch large it was of no consequence; in fact anything like real accuracy in machine fitting was in those days considered a drawback, as things did not then go together fast enough for all concerned. Everything was a rough, hammer and chisel fit with as little filing as possible. The treatment of workmen generally was abominable and continued so right down to within the past few years. The general slave-driving conditions in such workshops, or in very many of them, may be summed up: Drive! drive! drive! work, you devil! work! with an accompaniment of curses and often blows to clinch the argument. Let us be thankful that those days are gone forever in Russian workshops, as elsewhere. Here it must be said, however, that the piece-work system being universal the men earned good wages, which probably to some extent was a salve to the rough treatment they received all round but no excuse for it. The brutalizing treatment so freely meted out also has had its effect in preventing the Russian employee in the past from becoming a first-class mechanic.

APPRENTICES, PAST AND PRESENT

Apprenticeship systems have from the first existed here, but apprentices were taken more for cheapness of their labor than anything else; no idea existed that these youngsters needed instruction other than they would pick up. No one cared about the competence of a future generation of workmen. There was no money in that idea for these pioneers; if there had been, competent men would be abundant instead of scarce at the present day. Short-sighted wisdom on the part of the employers it has proved, and they suffer today because of this policy.

Bullied and cursed, beaten and driven by master and men, the youngsters in workshops in Russia in those days simply followed the doubtful lead of their elders, whose one idea, of course, was making as much by piece work as possible. They had no notion of teaching the lads, who often rather became worse workmen than those who went before them, until today the younger element in Russian shops are an unruly set of fellows with whom it is increasingly difficult to deal.

The present state of the law in Russia does not allow lads under 16 years of age to work full time in a workshop, and the position of learners is, from the absence of a properly organized system of teaching and pay, very bad both for them and for their employers. In former years, in the case of many old-fashioned establishments, there was a sort of agreement entered into by parents, with respect to their sons entering such shops. They lived on the premises, were fed, and sometimes clothed, received a few pence per week, and at the end of four years, if they had conducted themselves fairly well, they were paid a bonus equivalent to 10 to 20 pounds. Naturally, the skill acquired by these young men depended entirely upon themselves. A few turned out capable of doing the work of the shop where they had learned their trade, and were retained; but the majority went elsewhere, trying to earn full pay.

Today this system is disappearing, especially in the larger works, and in large towns. A lad is now taken on, say at sixpence per day for the first year, and progressive yearly increase is made till, at the end of the fourth year, he may be getting two shillings per day. Very many, however, prefer just getting enough knowledge to do a job badly, and then go knocking around from shop to shop, and from place to place, until they develop into regular second- or third-rate workmen, ever being ready with a cheeky reply to their foreman, if their errors are pointed out to them. This sort of thing is also tending to do any and everything except develop an intelligent, skilful class of artisans for the future.

WORKMEN IN VARIOUS OCCUPATIONS

The best workmen in Russia are undoubtedly rough carpenters, iron molders and smiths. To these trades the Russian takes like a duck to water. The perfection of finish is not of such moment as in machine processes, engine fitting, etc., in which the Russian workmen are lamentably deficient. The black trades workers compare favorably with foreigners; in fact, in molding and smithy work, they can turn out much more and better work than is done in many plants abroad, where facilities for education are more perfect. But the machine worker, the fitter, the patternmaker, the draftsman, they are poor indeed, and the sorrow of it is that they are not to blame for their failings any more than a heathen for knowing nothing of Christianity. The want of interest on the part of employers and foremen, and the absence of schooling, the lack of incentive to learn, the untidiness of their surroundings, and the total lack of system in so many workshops, have all tended to produce slovenly workmen. Add to this the wretched tool plants, cheap and inaccurate, when new, and run for years with no really intelligently made repairs, how then can it be expected that, under such conditions, workmen fail to understand accuracy, or need of it, in the work they do? Again it may be said that it is not the workman who is to blame, but mainly his money-grubbing employer.

PECULIARITIES OF EMPLOYERS

These people set out to make money, not nineteenth-century mechanics. They say in effect: "Let those that need teach their men to work to the 1000th of an inch; our needs don't demand it and it doesn't pay us dividends. If future generations of employers want to be engine builders, or fine-instrument makers and work on precision tools, let them start in and teach men to do such work; it is no concern of ours, and if later we want such workmen, why we can then get them from those who have taught them." From the view of such employers, this may be proper; but they might do their share by teaching their men to put in the very best work desirable on the class of goods they make; but they don't even do that. Work goes along in their shops in the old way, until a serious complaint comes in, relative to some line of goods they make. Then there is a hubbub and a row, after which things drift back to the former state. It is the lack of consistent, persistent striving to achieve what is best that is the universal failing in the great majority of Russian machine shops. There are a few concerns that are gradually adopting more advanced methods, even among the older established firms; but it will take many generations of such to rectify the almost irreparable damage of former years, due to their predecessors.

The more skilful workmen in Russia are mostly to be found in the government workshops, arsenals and dockyards, also in the engine shops in Moscow and the large locomotive works. Here there is not the same element of keen competition, and there is not the same drive that is to be found in shops turning out articles of rough construction. The conditions are essentially different, the men earn good pay, can work more leisurely and would not care to leave such places to go onto rougher work. The lads also get a better grounding in such works, but even these men, the best available in Russia, are a long way behind in skill as compared with foreign workmen doing the same class of work. They are better workmen only through their association with better tools and a better class of work and through being employed in better built, lighter and more cleanly shops. The discipline is also better under such conditions; and if there is one thing the Russian workmen hate as a body more than another, it is rigid discipline.

DISCIPLINE AND LACK OF IT

Under the Russian factory laws it is most difficult to enforce discipline, for however unsatisfactory an employee may be unless he is grossly impudent, 14 days' notice of discharge must be given or 14 days' advance pay if dismissed there and then. If a man is fool enough to "let loose" on receiving notice to go or on being found fault with, immediate dismissal is allowable by law; but as a rule in the case of a man being discharged he is too wide awake to be such an idiot, so he loafs his 14 days, or if a bad character, oils his lathe with "patent anti-friction" the last day, or breaks a few teeth out of his gears, or he softens all his tools, before handing them in, or perhaps quietly appropriates a few brasses of stealable size. Sometimes if he is a particularly bad rascal, there will be a combination of all these. Readers may say lock him up; nothing would suit our friend better. He would, if locked up, get housed, fed and be in, for him, congenial company for a week or a month with precious little to do except sleep, eat, drink and play cards perhaps. Or if it is a simple case of stealing a few brasses, the magistrate will say, "What! Ruin the man for this small matter! Oh, no! It is not to be thought of—he is discharged." So one grins, bears the trouble and loss and leaves prosecution severely alone.

EFFECT OF SPECIALIZATION

Then again the question of specialization, which perforce exists in works turning out hundreds and thousands of the same machines year in and year out, affects the workman and the quality of his work under the conditions already mentioned. With poor plant, much of it obsolete and worn out into the bargain, the work is forced at breakneck speed to catch the seasons, or fulfil contracts under penalties, little checked and under no really effective system of inspection, and these conditions must in the nature of things tend to produce slovenly workmen of the first water. Parts are machined and fitted that should be scrapped, machine operators, fitters and erectors saying nothing. They do their utmost to cover up the mistakes made in molding, forging, etc., for their comrades; and when it is borne in mind that this sort of thing has been going on for years and years, one can form some idea of the troubles besetting managers relative to workmen in Russia, who, even though they are aware of all this, are mostly in such a difficult position that they cannot make the changes necessary to eradicate such abuses.

SOME CHARACTERISTICS OF THE WORKMAN

Another matter tending to keep the status of the workmen at its lowest is their seemingly absolute want of personal pride. They will wear their working clothes year in and year out until they almost drop off and no attempts to better this condition seem to produce results. In many works wash rooms and clothes lockers are to be found, well fitted up with hot and cold water, etc., but though many men just take off the surface dirt very few indeed wash clean, and change their working clothes. The money spent in this way so far seems absolutely wasted. To attempt compulsion would end in absolute failure at present and advice seems of no use.

Damage to plant and tools is excessive in all workshops and no amount of fining or system seems to help. It seems impossible to instil the feeling of care into the men as a whole; they do not value their own things much and they seem quite unable to grasp the fact that all tools cost money. The small tools so prized and jealously guarded by workmen abroad as their own and the pride taken in them, their quality and usefulness, the Russian does without. He generally has a broken German wood rule and may have a pair of calipers such as a foreign apprentice boy would not own, perhaps a center punch with no point to speak of, and that is all; and in many shops half the men don't possess these—they just borrow from those who have them.

It is all a great pity that the Russian mechanic taken as a whole is such a difficult subject, and the more so as the blame for it lies with others more than with him. As a man he is, as a rule, a fine fellow and a first-rate comrade, strong and willing, but he has been so handled that the wonder is, he is no worse as a workman than he is. It says much for the chance of his future development into a skilled worker, that he is wonderfully quick to learn, and if pains were taken to teach him to do right and only right, at the commencement of his career, he would become as fine a workman as any under the sun. Let us hope that in the no distant future serious and sustained effort will be made by all in authority over him to that end.

Russia.

Large Generators for the Soulanges Canal Power Station

The Montreal Light, Heat and Power Company has recently contracted with the Canadian Westinghouse Company, Ltd., for a large addition to its power equipment. The apparatus contracted for is for the new Soulanges Canal power station on the St. Lawrence river. The equipment consists of three Westinghouse 3750-kw. revolving-field alternating-current, two-bearing generators connected to water turbines. These generators are 7200 alternations, 4000 volts, three-phase, operating 225 revolutions per minute. There are also two Westinghouse 150-kw. direct-current 125-volt exciter units. Westinghouse 2500-kw. oil-insulated, water-cooled transformers to the number of thirteen are an important part of the equipment. Seven of these transformers will be used for raising the voltage at the generating station from 4000 to 44,000 volts, and six of them will be used at the lowering end of the transmission line, stepping down the voltage from 44,000 to 12,000.

The first electric train entered the Grand Central station, New York City, on September 30. It was a special, composed of two private cars and five Pullmans, drawn by electric locomotive No. 3406.

Titles For Drawings

BY GERALD E. FLANAGAN

Uniformity in the titles of all drawings in a given establishment is much to be desired, and is usually attained by printing, with a rubber stamp or otherwise, such parts of the title as are common to all drawings. The form of title to be adopted should receive serious consideration and not afterward be departed from until good and sufficient reason appears for making a change. In strictly mechanical work, all idea of making an ornamental title should be abandoned, nothing being admitted except what is regarded as absolutely necessary, the whole being arranged with a view to clearness and distinctness, giving prominence to the features to which reference will most frequently be made.

Matter which may properly be considered as office memoranda is often combined with the title, the whole being inclosed in a rectangular space subdivided to separate the various items. The principal fault with this arrangement is a lack of clearness; among so many items it is difficult to give any one sufficient prominence to insure that it will appeal strongly to the eye without being confused with extraneous matter. This method may be much improved by including within the rectangle only such matter as is common to all drawings, and placing the title descriptive of each individual sheet in a clear space above or to one side of it. This descriptive title is often under-ruled with heavy lines or lighter double lines, under the mistaken impression that the feature in question is emphasized thereby and rendered more distinct. Nothing could be further from the truth. Black lettering upon a plain white ground is unexcelled for distinctness; the value of simplicity and the use of plain surfaces is recognized by all experts in artistic design, and it is a principle that should not be overlooked nor disregarded by engineers and mechanics.

Fig. 1 is a style of title which includes some office memoranda. It records the names of all persons directly concerned in making the drawing; bears the signature of the engineer responsible for the design, and also that of the chief draftsman, indicating that it is correct for the contract in question. Sometimes a space is left in which to stamp the serial number of each print as it is made, but this is just as well placed elsewhere, to avoid confusion with the drawing number and contract number.

Frequently it is deemed advisable to provide a space in which to state the number of drawings required to complete the job or contract, and to give a letter or a consecutive number to each sheet in the series. This introduces additional complication and should be avoided except under such conditions as render its advantages very obvious. A better plan is to place upon the general drawing a list of the detail sheets, giving the serial number and descriptive title of each. This involves greater labor but it usually saves several times its cost. The method of dispensing with serial numbers for drawings, and commencing each job or contract with drawing No. 1 combined with the contract number, is strongly favored by some engineers; but the convenience which this system affords is obtained by the sacrifice of the immense advantage of the serial number, which avoids all possibility of one drawing being mistaken for another.

It is customary to give the scale of a drawing in the form of an equation such as 1½ inch = 1 foot. The latter part of this expression is superfluous and consequently objectionable. If we simply note, scale 1½ inch, all who know enough to use drawings will understand what is meant, and if additions are made later it may be extended without erasing, to read scale 1½-¾-½, etc. For a similar reason, the words "drawing" and "contract" in the title are not followed by the word number, either in full or abbreviated, and there can be no possible difficulty resulting from their omission.

The relative proportions of such a title have a considerable influence upon its usefulness. The drawing number is generally of importance to all concerned and should be given special prominence, and the contract, order or job number, as the case may be, should also be clear, but very much subordinate to the drawing number. Placing the drawing number in a circle while all other parts of the title are inclosed by rectangles is one method of giving it special prominence.

It will be observed that a column is provided for the date of the drawing, giving ample space for frequent revisions. This is a matter of first importance; every time a change is made upon a drawing after the first print has been issued, the fact should be noted in order that it may be positively known what stage of the drawing is represented by the prints in use; it is best to make it a rule to avoid using prints for any purpose except those bearing the latest revision mark. The first line in the revision column indicates the date upon which the tracing was finished, subsequent changes being noted by giving a later date on one of the lines beneath. When a new date is added the previous one should be crossed out, but in such a way that it may be deciphered if necessary. This may be done by thin lines, or a wash of diluted ink may be painted over the numbers. There is a space for the initials of the draftsman making the change, and also for a number, which latter indicates a memorandum upon which will be found a description of the change and the reasons for making the same, and any other data which may be required for future reference, but with which it is not deemed advisable to encumber the drawing. These revision notes should be kept in books with the pages numbered consecutively, blank forms being printed to save labor and secure uniformity; a carbon copy is attached to the tracing when a change is made, which enables the chief draftsman to note the change and the reasons therefor, and also to send the memorandum copy to the proper person, who will recall previous prints, issue new ones as required and also shop orders and requisitions for material.

Fig. 2 is a form of title formerly very

DIAMOND STEEL COMPANY
MILL No. 3.
20″ STEAM MAIN
SCALES 3/8″ — 1 1/2″ — 3″

CONTRACT 563	BLANK ENGINEERING CO. CHICAGO, ILL.			
APPROVED	EARLIER PRINTS VOID			DRAWING
CORRECT	4-9-06	G.T.N.	1237	
	7-12-06	R.S.G.	1314	
DRAWN BY				
TRACED BY				
CHECKED BY				6518

FIG. 1

BLANK ENGINEERING CO. CHICAGO, ILL.	CONTRACT 563
20″ STEAM MAIN IN MILL No. 3. FOR THE DIAMOND STEEL COMPANY	
DRAWN BY	SCALE
TRACED BY	DATE
CHECKED BY	
REVISED BY	DRAWING 6518

FIG. 2

TWO FORMS OF DRAWING TITLES

much used, but it is less favored of late years than one similar to Fig. 1, which is considered to present the various items more clearly and to more fully indicate their relative importance.

Tracing cloth should be kept ready cut to size, with border lines ruled and parts of the title which are common to all drawings printed with a rubber stamp and traced over with drawing ink, leaving only the number, date and descriptive title to be filled in when the drawing is made. This can all be done by boys at low wages and save the time of higher-priced men, in addition to facilitating work which may be wanted hurriedly. Drawing paper should also be kept on hand, cut into sheets of the proper size, with the title stamp in the corner. This may be filled in with lead pencil and the drawing given the same number as the tracing, serving to identify it until such time as it has fulfilled the purpose of its existence.

The Southern Pacific's Technical School for Its Employees

Away out in the western part of Nevada, among the Sierra Nevada mountains, at Sparks, which is the next station to Reno, the Southern Pacific Railroad Company is going to establish a technical school for its employees. There will be two classes, one for apprentices, who will receive pay for the time spent in the school the same as if they were at work in the shops; and the other for the machinists, car men, etc. The railroad company hopes that the increased efficiency of the men resulting from the better education will reimburse it for the cost of the school. The school will be under the supervision of the near-by University of Nevada, and instruction will be given by professors from the university. All the shop foremen were consulted regarding the educational plan, so as to insure that the information imparted will be as useful and practical as possible. The subjects which will receive special attention will be arithmetic. elementary mechanics, mechanical drawing and valve gears. The apprentices' class will be held every Monday and Tuesday morning from 7 to 9 o'clock, and the machinists' every Monday and Tuesday evening from 7 to 9 o'clock. A project of this kind, if properly planned and carried out, should be very advantageous to all parties concerned, and if the men have a proper appreciation of it, it appears that the enterprise should prove very successful.

According to the *Mechanical Engineer*, of London, the output of bessemer steel in Great Britain for the first half of 1906 has been 919,620 tons, a decrease of 100,267 tons, compared with the corresponding period of 1905. Of the total output for the first six months of this year 634,838 tons were acid and 284,782 tons basic steel.

ENGINEERING REMINISCENCES*

Modernizing the Southwark Plant — The President's Autocratic Behavior and its Disastrous Results—An Overcharge that Lost Us $100,000 of Yearly Business—Disadvantages of Responsibility Without Authority

BY CHARLES T. PORTER

With a number of other engineers I attended, by invitation, a meeting held at the office of the AMERICAN MACHINIST, February 16, 1880, which determined upon the organization of the American Society of Mechanical Engineers, and soon after I had the honor of being invited to read a paper at the first regular meeting of this society, held in the auditorium of the Stevens Institute, at Hoboken, N. J., on the 7th of April following. I read a paper on the subject of strength in machine tools.* The date of this meeting, it will be observed, fell during the time when the Philadelphia expert was racking his brains to concoct for me an application for a patent reissue which he felt sure could not be allowed.

TWO MACHINE TOOLS DESIGNED

The following summer I employed some of my leisure time in making the plans for a couple of machine tools. One of these was a double-drilling machine for boring the boxes of connecting-rods, there being then no such machine in existence to my knowledge. I had been planning such a machine in my mind as long ago as when I was in the works of Ormerod, Grierson & Co., in Manchester, England, in 1864-5. This tool was designed first to bore the two boxes simultaneously and rapidly, and secondly to bore them with absolute accuracy in their distance apart and in the intersection by their axes of the axis of the rod at right angles in the same plane, and all this without measurement or setting out or the possibility of error. The other tool was comparatively a small affair. I utilized an old milling machine for facing simultaneously the opposite sides of nuts and taking the roughing and finishing cuts at the same time. The ends of the nuts were first faced on a special mandrel which insured their being normal to the axis of the thread. A string of these nuts was threaded on a mandrel fitting the top of their threads and some 15 or 18 inches long, on which they were held against a hardened collar, the diameter of which was equal to the distance between their opposite finished faces. The cutting tools were set in two disks about 12 inches in diameter; they were set about an inch apart alternately in two circles. one about one-eighth of an inch inside the other, and were held in position by set-screws in the periphery. The cutters in the outer circles did the roughing, those in the inner circles were set projecting about 0.001 of an inch beyond the roughing tools and finished the surfaces. The mandrel was set between centers and the string of nuts was supported from the table at the middle of its length. The nuts were secured in position by a dividing plate on the forward center bearing. What was done with the two drawings I will state presently.

My success, as already related, came so swiftly and completely after six months of anxiety as to be almost overwhelming. The more I thought about it the more ecstatic I became; all my disasters had been of a nature the effect of which time would soon efface. I was full of high anticipations, I could see no cloud in the sky; I awakened to my old zeal and energy and set myself eagerly to the work of providing new equipment, unable to realize the real helplessness of my position. Little did I dream that I was already doomed to drink to its dregs the bitter cup of responsibility without authority. That story will come soon enough; now I will ask the reader to accompany me in my work of filling the shop with new tools.

TOOLS FROM ENGLAND

My principal orders were sent to my old friends, Smith & Coventry, in England. Among others I sent one for my double-drilling machine, with the drawings. I received a reply from them stating that they had just furnished a similar machine to the firm of Hick, Hargreaves & Company, the eminent engine builders of Bolton, and that they thought I would prefer their design for this machine to my own. I should think I did prefer it; it was simply wonderful. It presented one feature of especial interest, which was that the two drills were driven independently and when not employed on connecting-rods could be applied to any other drilling work. So I ordered that tool and its work fully justified my expectations. I ordered from them several planers, the largest one passing a body five feet square. I was filled with admiration at what they sent me. The tables of the planers were provided with broad, flat shoes running on corresponding flat guides, the sideways wear being taken up by an adjustable gib on one side. This construction enables the bearing surfaces to be made one true plane from end to end, making cross-wind impossible. The next feature by which these planers were distinguished was the mode of lu-

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bricating these surfaces. Each guide was provided in the middle of its length with an oil-well which was a large square box, formed in the casting. In the middle of this box was a small rod on which two levers were pivoted, the arms of which were of equal length. At one end these arms carried a roller and at the other end a weight considerably heavier than the roller. The roller was thus kept up against the under side of the shoe, while its lower side ran in the oil; thus the lubrication was effected by the revolution of this roller which needed to be only one-half the width of the face lubricated; this was found to be the perfection of lubrication. The tables were very stiff and were provided only with T slots from end to end for holding the work.

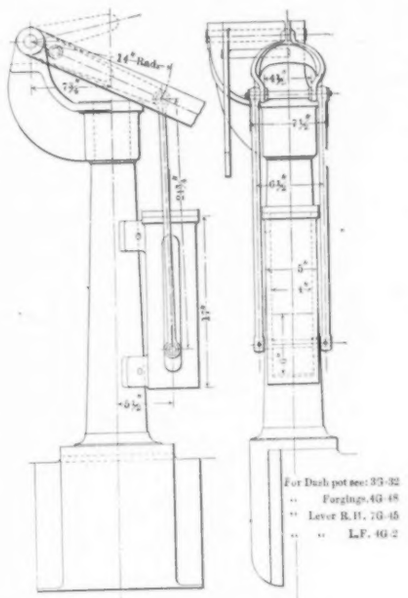
I should note also an original machine from the same makers for threading bolts at one motion and without the use of centers. The rod is fed through a hollow spindle, seized centrally by jaws on the face plate and threaded by three dies set at the angle of 120 degrees apart, which are closed and opened equally by cams in a solid ring. These cams are operated by a lever, which is held up against an adjustable stop determining the depth of the cut. The first three threads in the dies are tapered, so the thread is finished in nine cuts. This tool is admirably adapted for threading standing bolts for cylinder heads. One end having been threaded to screw hard in the head, the stop is advanced a trifle and the other end is screwed easy for the nuts.

I built a one-story addition to the erecting floor, about 40x100 feet, occupying a space which had been used before mostly as a stable. I divided this into two bays by columns and provided each bay with an overhead traveler of about ten tons capacity worked by rope loops hanging to the floor. These were also made for me by Smith & Coventry.

I ordered from Mr. Moore, of Philadelphia, one or two of the heavy and powerful lathes built by him for turning chilled rolls. I also ordered a six-foot square planer from the Hewes & Phillips Iron Works, in Newark, which they made expressly heavy, having become infected with my ideas on that subject. From Pratt & Whitney I ordered one large lathe and one or two small planers, and other tools from several American makers.

A DEFICIENT BORING AND TURNING MILL

In one instance only I was disappointed; that was the case of a 12-foot horizontal turning and boring machine. On examining the blue-prints which were sent me at my request, I was struck with the lightness of the table, and conditioned my order on this being made twice as heavy, which was done. If I had made the same requirement for every other part of the machine, I should have done a good thing for both the builders and myself. The table ran on a circular track, which was superbly designed. This track consisted of a circular trough perhaps 8 or 10 inches wide, and in the middle of it a bearing surface for the table, raised perhaps half an inch above the bottom of the trough, and half an inch lower than its sides. This bearing surface was about 6 inches wide, and was intersected by diagonal grooves about a foot apart. Oil could stand in this trough above the level of the bearing surfaces. I made a little improvement on the method of supplying the oil. As sent, a dose of oil was poured through a hole in the table, which was filled with a screw plug when not required to be used. I screwed a plug into that hole to stay, and drilled a hole in the bottom of the trough, in which I screwed a ⅜-inch



Porter-Allen Engine 40" x 48" #207
Dash pot for Governor.
Southwark Foundry Phila. May 10th, 1881

pipe that I carried under the bottom of the machine, and up behind one of the uprights to a higher level, and in the end of this pipe I screwed a sight-feed oil cup. I provided a drain pipe, which would maintain the oil in the trough at the desired level, while it was fed to the trough continually, drop by drop, as required. This table came with an imperfectly finished bearing surface. I set several men at work to bed these surfaces properly, and did a fine job of scraping on them. When it was finished, I pulled the table around with one hand, it floating dry on the air caught between the two surfaces. When we came to use the tool it chattered, and would do so however light the cut we were taking; every part of it was too light and vibrated, except the table. After all, it was the best tool of this kind and size that I could have got in this country. If made of proper strength, I should have been able to use four cutting tools in the work, each leaving a perfectly smooth surface; but that was a degree of strength and usefulness that builders at that time had not dreamed of.

One of the first of our smaller engines I built for ourselves, setting it in a location convenient for transmitting power to both the machine and erecting shops. On my recent call at the Southwark Foundry, already mentioned, Mr. Brooks called my attention to the engine, saying the only thing they had ever done to it was to increase its speed about 50 per cent. to meet their increased demand for power.

REPAIRING THE LARGE PLANER, ETC.

The job of taking the cross-wind out of the great planer interested me perhaps more than anything else, on account of its difficulty. It was a long time before I could decide how to go about it; besides the cross-wind the guides were not parallel; at one end the V's on the table bore on one side, and at the other end at the opposite side. I finally made an apparatus consisting of two V's about three feet long, and connected by a cross-bar on which was set a spirit level having a ground bubble. Another similar level was set on top of one of the V's. With this apparatus, which was strong enough, and was finished in the most perfect manner, and a brass wire, I was able to determine beforehand what was necessary to be done at every point in the guides. To finish this job on the bed, and afterward on the V's under the table, required fully three months' work, including the time spent in preparing the apparatus, a job I could not begin until I had our new planers. When it was done I was able to make a perfect job of the great engine beds already mentioned, and other work which was waiting for it.

Among the old tools was one large drilling machine, the size of which and the strength of its framing impressed me very favorably; but when we came to use it, we found it would not drill a round hole. This defect could doubtless have been remedied by grinding the spindle, when we got a tool in which to do it, and fitting new boxes. It was determined, however, by Mr. Goodfellow and myself, that it would not be worth while to bother with it, because it had been so badly designed that the two traversing screws for the compound table, with which it was furnished, were located centrally, and so crossed each other exactly under the spindle. It was, therefore, impossible to use a boring bar in this tool, and its usefulness was ridiculously disproportioned to its size. The contrast between it and the Smith & Coventry drill, which was set in its place, was really wonderful. We had no trouble in disposing of this and all other rejected tools to parties who were delighted to get them cheap. It took us about six months to get rid of all the rubbish and fill the works with the best tools then obtainable, though still deficient in many respects, as, for

instance, the great planer, which had only one cutting tool on the cross-slide, whereas a planer of that size should be provided with four cutting tools—two on the cross-slide and one on each upright.

NOT CONSULTED EVEN IN PURELY ENGINEERING MATTERS

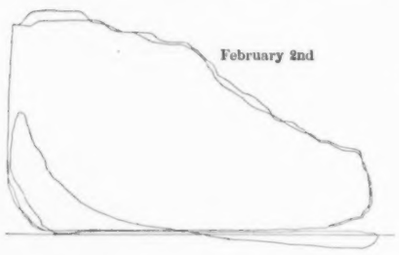
I observed that as our facilities for doing work were increased the belief that I was unable to execute orders became general through the country and applications at first numerous dwindled to almost nothing. United and well directed action would soon have put a new face on matters, but now I was to meet with obstacles that time could not overcome. Mr. Merrick had grandly confessed his two great mistakes but unfortunately he continued to make mistakes to the end of the chapter. He was naturally a very reserved man, I may say secretive. He assumed as president supreme authority, never consulting me about anything, and indeed I never knew what he proposed to do or was doing until I found it out afterward.

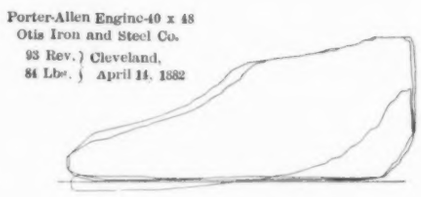
AN ORDER FOR AN ELECTRIC LIGHT PLANT

For example, about the first order we had was from a company formed for lighting the streets in Philadelphia with arc lights, of which Thomas Dolan, a prominent manufacturer in Philadelphia, was president. Our order was for eight engines 8x16 inches to drive eight Brush dynamos each of 40-light power. The order was given to Mr. Merrick. I never saw Mr. Dolan; his own mill was at the northern end of the city and he met Mr. Merrick by appointment at lunch in the business center, to which conferences I was never invited. When the plant was in operation I heard incidentally that they had got a new engineer at the electric light works and I thought I would go up some evening and make his acquaintance. I was met at the door by a stranger who politely showed me the plant. I did not introduce myself. He asked me if I was interested in electric lighting; I told him I was not but might be. He said it was his duty to warn me against the use of high-speed engines; he should not have advised these but found them already installed when he took charge of the place, and he was doing the best he could with them for the present, but the works would be greatly enlarged after a while, when these engines would be gotten rid of and proper engines substituted in place of them. He called his assistant to testify to the difficulty they had in getting along with them. I looked around and saw the eight engines running smoothly and silently at 280 revolutions per minute but I said nothing. The next morning I made an early call on Mr. Dolan at his office. I introduced myself to him, although I think he knew me by sight. I told him the state of affairs I found at the electric light station and received from him in reply the following astounding statement. He said: "Mr. Porter, when this company was formed I selected the Southwark Foundry as our engineers. I had previously become acquainted with the running of some of your engines and had come to the conclusion that they were just what we needed; accordingly I ordered our first engines from you. I assumed that the engineering department of this enterprise was in your hands and that you would be represented there by an engineer selected by yourselves and devoted to your interest. Accordingly when your men had finished their job and had left only one man in charge of the engines, I applied to your president to send me an engineer. He sent me a workman. That was not the kind of man I wanted; the engines were in charge of a workman already, a man from your own works. I wanted an educated man who could represent us in the courts and before the city councils, in short an engineering head for this business now in its infancy, but which was expected to grow to large proportions. He ought to have known what I wanted, or if he did not he should have asked me; his whole manner was entirely indifferent, he seemed to take no interest in the enterprise.

"Seeing I could get no help from Mr. Merrick, I applied to William Sellers for an engineer; he sent me a young man from his drawing office and I soon found out he was not the man I wanted; he knew nothing about a steam engine—was merely a machine-tool draftsman—so I found I must rely upon myself. The only man I could think of was this man I have. He had done some good work for me some two or three years ago in repairing one of my engines, so I offered him the position which he accepted. I knew nothing of his engineering preferences; he seems to be doing very well and I am afraid he will have to stay."

The result was most remarkable. A demand for electric lighting plants was springing up all around. This became widely known as a pioneer plant and was visited daily by parties who were interested in such projects. These visitors were met at the door by the engineer and his assistant and were warned, just as I was, to have nothing to do with a high-speed engine. They were always business men, quite ignorant of machinery, and with whom the testimony of two practical men who had experience with the engines was conclusive. The result was that we never had a single application to supply engines for electric lighting. Yes, we did have one application; a man came into the office, when I was there alone, and gave me an order for his mill, and apologized to me for giving it. He said the place where he was obliged to locate his lighting plant was so limited, he found he could not get in the engine he wanted. This result I felt especially exasperated at when a year afterward the secretary of the lighting company, who had his office at the station, told me that he had done something of which he knew his directors would not approve; he had sold every light they had. There was plenty of reserve power in the engines, but the dynamos were running to the limit of their capacity. He had felt safe in doing this, because no one of the engines had failed them for an instant. For his part he could not see what those men were for—there was never anything to do except to start and stop the engines as required, and attend to the oiling. I always felt that this great disaster would have been avoided if Mr. Merrick had conferred with me with respect to Mr. Dolan's most important request.





AN EXPERIENCE WITH THOMAS A. EDISON

The following story is too good to keep, although the incident had no effect that I am aware of, to accelerate my downward progress. While in Newark, I had built for Mr. Edison an engine for his experimental plant at Menlo Park. The satisfaction this engine gave may be judged by what follows: One day I had a call from Mr. Edison, accompanied by Charles L. Clarke, his engineer. They had been walking very rapidly, and Mr. Edison, who was rather stout, was quite out of breath. As soon as they were seated, without waiting to recover his wind Mr. Edison began, ejaculating each sentence while catching his breath: "Want a thousand engines." "Thousand engines." "Want you to make the plans for them." "Have all the shops in New England working on the parts." "Bring them here to be assembled." "Thousand engines." In the conversation that followed I gently let Mr. Edison down, not to the earth, but in sight of it. The result was that two or three weeks afterward I was injudicious enough to accept from him an order for twenty-four engines, luckily all of one size and type. This was to be a rush order, but it called for new drawings and patterns, as he wanted a special proportion of diameter and stroke, larger diameter

and shorter stroke, than those in my table. Before the drawings and patterns were completed Mr. Edison, or the people associated with him, discovered that they had no place to put more than six of these engines, so the order was reduced to six. These were for a station which was being prepared on the west side of Pearl street, a few doors south of Fulton, New York City. Three of these engines were finished first. After they had been running a few days, a defect of some kind, the nature of which I never knew, was discovered, and Mr. Edison's attention was called to it. He charged it to the engine, and exclaimed impetuously: "Turn them out, turn them out!" It was represented to him, however, that they could hardly do this, as they were under contract for a considerable amount of light and power, and the current was being furnished satisfactorily. "Well," said he, "we'll have no more of them at any rate," so the order for the remaining three engines was countermanded, and three Armington & Sims engines were ordered in place of them. When these were started, the same difficulty appeared with them also. A fresh investigation disclosed the fact that the difficulty was entirely an electrical one, and the engines had nothing to do with it. Mr. Clarke claimed that had been his belief from the beginning. So the thousand engines dwindled to three engines sold and three thrown back on our hands. The two triplets ran together harmoniously until in the development of the electrical business that station was abandoned.

AN OVERCHARGE ON A BILL AND ITS RESULTS

E. D. Leavitt, Jr., brought us the business of the Calumet & Hecla mine directly after we began to do work. He brought it to me personally on account of his admiration for the engine, and also for the character of work which I had inaugurated. His first order was for an engine of moderate size. While that was building he brought us a small order for a repair job amounting, perhaps, to a couple of hundred dollars. That work was spoiled in the shop by some blunder and had to be thrown away and made over again. By accident I saw the bill for that job; a green boy brought it from the treasurer's desk for Mr. Merrick's approval. We both happened to be out, and by mistake he laid it on my side of the table. I came in first, picked it up and read it, and saw that it was for the full amount of the material and work that had been put on the job. It seemed to me quite double what it ought to be. I laid it on Mr. Merrick's side and, when he came in, told him how I came to see it, and I thought it should not be sent, being so greatly increased by our own fault. "Oh," said he, "they are rich; they won't mind it." I said: "That is not the question with me; I don't think it is just to charge our customers for our own blunders." He smiled at my innocence, saying: "If a machine shop does not make its customers pay for its blunders, it will soon find itself in the poorhouse." "Well," said I, "I protest against this bill being sent." However, it was sent, and in the course of a few days a check came for the full amount and Mr. Merrick laughed at me. Weeks and months passed away and he had heard no more from Mr. Leavitt, when I met him in New York at a meeting of the council of the Society of Mechanical Engineers. When the meeting was over he invited me to dine with him. After dinner he said to me: "I suppose you have observed that I have not visited the Southwark Foundry lately?" I told him I had observed it. He then said: "Do you remember that bill?" I told him I did very well, and how vainly I had protested against its being sent. He said: "When that bill was brought to me for approval, I hesitated about putting my initials to it until I had shown it to Mr. Agassiz. I told him what the job was and the bill was quite twice as large as I had expected. He replied, 'Pay it, but don't go to them any more,' and I have taken our work to the Dixon Manufacturing Company at Scranton." I realized that I had lost the most influential friend I had since the death of Mr. Holley. I heard some years after, though I do not vouch for the correctn ss of the story, that the work of the Calumet & Hecla mine sent to the Dixon Manufacturing Company, had in one year exceeded one hundred thousand dollars.

AN INVASION AND USURPATION

Some time previous to these events, Mr. Merrick had done a very high-handed thing. Assuming supreme power as president of the company, he had invaded my department, and without a word to me, had appointed over Mr. Goodfellow a superintendent to suit himself, reducing Mr. Goodfellow to be general foreman of the machine shop, to take his orders from the new superintendent and not from me, whereupon Mr. Goodfellow resigned, and accepted a position as master mechanic in the Pennsylvania Steel Works, and by his advice the engine ordered by them from me was taken from the Southwark Foundry in its incomplete condition and finished by themselves under Mr. Goodfellow's direction. Mr. Merrick then filled Mr. Goodfellow's place with another friend of his own as general foreman. I was fully alive to the arbitrary nature of this usurpation, but was entirely helpless, knowing perfectly well that the directors would sustain the president in whatever he did.

THE NEW SUPERINTENDENT AND HIS WAYS

With the coming of the new superintendent, the fatal change took place. He came, first of all, full of the superiority of Philadelphia mechanics, and second, feeling that in the nature of things I must be entirely ignorant of anything mechanical. I was nothing but a New York lawyer; never did a day's work in a shop in my life; had gone into a business I was not educated to and knew nothing about. My presuming to give orders to mechanics, and Philadelphia mechanics too, filled him with indignation. He would not take an order from me—perish the thought—and as for my drawings, he would depart from them as much as he liked.

All this appeared by degrees. I observed on the floor several cylinders fitted up, in which the followers for the piston-rod stuffing-boxes were made sliding fits on the rods. I asked him why he had made them in this way when they were drawn and figured to be bored 1/32 inch larger than the rod. He replied, "Because this is the way they ought to be." I told him every one of them would be fired before the engine had run an hour; that I wanted him to bore those followers to the drawings, as well as the cylinder heads back of the stuffing-boxes. "It shall be done sir," said he. On examining them after this had been done, I found he had turned as much off from the outside of the followers as he had bored out of the hole. I asked him why he had done that. He said he supposed if I wanted the inside to be loose, I wanted the outside to be loose too. I told him I did not. He asked me why. I told him I was not there to argue with him; I wanted him to throw those followers away and make new ones precisely like the drawings, and I saw to it myself that it was done. I went to Mr. Merrick about this matter, and can the reader imagine what his reply was? "My advice to you, Mr. Porter, is to leave all such matters to the superintendent." Think of it; an amateur president assuming the direction of my business, and giving such advice to me, who never had left the least thing to anybody. I realized that I was absolutely alone, but I felt very much like fighting the whole world. The above incident is a fair sample of my constant experience. I was on the watch all the time. Many times I required the work to be done over when the superintendent departed from my drawings, and in doing it over he generally contrived to ruin the job, and would say, "Just according to your orders, sir." I was reminded of a story told of Dr. Beman, a minister of Troy, N. Y., whose wife was peculiar, to say the least. On one occasion the presbytery met in Troy, and he invited its members to his house and told his wife to provide just a light supper. When they were ushered into the supper room there was nothing on the table but lighted candles. "A light supper," said she, "just as you ordered, sir."

I proposed to appoint an inspector to represent me. The general foreman said if an inspector was appointed he should resign, and Mr. Merrick forbade it.

AN ENGINE FOR THE OTIS STEEL WORKS

The second of the large engines which I finished was for the Otis Steel Works. I went to Cleveland myself to start the

engine and found that Mr. Wellman had it running already. Mr. Otis was very much pleased with it and well he might be. This was the first mill to roll plates from the ingot to the finish without reheating. This was the kind of diagram it made (Fig. 1). In rolling these heavy plates the changes were made instantaneously from full load to nothing and from nothing to full load. The engine made 90 revolutions per minute and it will be seen that the changes were made by the governor in a third of a second or less, the speed not varying sensibly. Mr. Otis said to me: "Oh, Mr. Porter, what shall I do with you? You cannot imagine the loss I have suffered from your delay in furnishing this engine." I said: "Mr. Otis, you know the terrible time I have had and that I have done the very best I could." "Yes," he said, "I know all about it." He had, in fact, been to Philadelphia and seen for himself. He added, "You make a small engine suitable for electric lights; what is the price of an engine maintaining twenty-five arc lights?" I told him $1050. "Well," said he, "you should strike off the odd fifty and let me have one for a thousand dollars, and we will call it square," so I had some sunshine on my way. The engine is now running as good as new after twenty-five years, and the company five or six years afterward put in another 48x66-inch to drive a still larger train.

EVERY ENGINE SHUT DOWN

I had a funny experience at the Cambria works which has always seemed to me to have been prophetic. In August, 1881, the Society of Mechanical Engineers held a meeting in Altoona, and the Pennsylvania Railroad Company gave us an excursion to Johnstown to visit the works of the Cambria Company. The anticipations of the members were expressed by Jackson Bailey, then the editor of the AMERICAN MACHINIST. As I was going through a car in which he was seated he called out to me, "This is your day, Porter." The party was taken in charge by Mr. Morrell, the general manager. Our route took us first to their new blast furnaces where considerable time was spent in examining their new and interesting features. Next we came to my second engine, started some two months before. The engine was just being slowed down; we were told there were not yet furnaces enough to keep the train running continuously, so they were shut down from half an hour to an hour between heats, and a heat had just been run off. We went next to see my rail-mill engine which had raised the output of that mill 150 per cent. That too had been shut down. They had just broken a roll, a most rare accident, and one which I had never before seen or heard of there. "Well, gentlemen," said I, "at any rate I can show you my engine driving a cold saw." Arrived at the spot, we found that all still, and were told that sawing cold rails was not a continuous operation and the men had gone to their dinner. That was the end of the show, as far as I was concerned. The Gautier works were a mile away and were not included in our visit, so we were entertained with the great blooming mill in operation and the casting of the enormous ingots for it, and after the customary luncheon and speeches we returned to Altoona.

BOUND TO MAKE THINGS FAIL

One day the superintendent came into the office and told me he had tried my machine for facing nuts and it would not work. I felt disappointed, because I had confidence in it. I went out to see what the matter was, and at a glance I saw that it had been ingeniously arranged not to work. The feed had been made rapid and the cutting motion very slow, so that the tools could not take their cuts and the slow-moving belt ran off the pulley. I did not reduce the feed motion but increased the speed of the cutters some eight- or ten-fold and the speed of the belt also, when the trouble vanished. I never knew anything to work better than that tool did.

The burning anxiety of the superintendent was to show up my ignorance. A first-rate chance to do so soon presented itself. The counterpoise of the Otis engine dropped instantly to its seat when a plate struck the rolls and as instantly rose to the top of its range of action when it left them. This made a noisy blow which was disagreeable, and might in time cause an accident. Mr. Wellman sent me a sketch of a device he had though of for arresting this motion by air cushions. I told the superintendent to have that apparatus made and make the air cushions four inches in diameter. He said four inches diameter would not answer; they must be eight inches. "No," said I, "four inches diameter is ample; make them four inches." A few days after he called me into the shop to try my four-inch air cushions; I found the apparatus secured in a vise in a vertical position. I took hold of the lever and lifted the piston; it met with no resistance until it struck sharply against the end of the chamber. For a moment I was stunned by the man's audacity, and threw the piston up and down again to make sure it was not a dream. I then turned my back on the superintendent and called to a boy to find Mr. Fulmer, the foreman of the second floor, and to tell him I wanted him here. In a moment he apperaed, and I said to him: "Mr. Fulmer, I want you to make a new piston for this apparatus and make it a proper fit, you understand." Mr. Fulmer bowed assent. I added: "There will be time today to get it into the sand and it can be finished early tomorrow. When it is ready for my inspection come yourself to the office and let me know." About the middle of the next forenoon Mr. Fulmer called for me; I went in and found the piston arrested at each end of its motion by a perfect air cushion. "All right," said I, "see that it is shipped today."

Mr. Fulmer was an excellent mechanic and a man of good general intelligence; he would have made the piston a proper fit in the first place if he had not been expressly ordered to make it loose and useless. The superintendent, on his general assumption that I was a fool, had actually expected me to say when I tried the apparatus: "Oh, I see, four inches diameter will not do. You will have to make it eight."

A Course in Business Management

We have received from the West Side Young Men's Christian Association, of New York City, a prospectus, giving information regarding the third season of its course in Business Management, which commences on Thursday evening, November 8, 1906. Last season two courses were conducted; one in Executive Problems, and one in Modern Office Methods. This season these courses will be combined into one course, and will be conducted by M. W. Montgomery, of the Library Bureau. The outline of the course includes 20 divisions, of which we give a very few as samples: Industrial organization, principles of purchasing, order department, perpetual inventories, receiving department, shipping department, the organization of a selling force, advertising, bookkeeping department, the solving of a factory problem, etc. The class will meet on Thursday evenings at 8 o'clock, and will continue for 20 weeks, excluding holidays.

Variable Volume of Air at Fixed Speed of Blower

It is a peculiar function of a fan blower that instead of always delivering a fixed volume of air, regardless of requirements, it automatically increases the volume as the resistances are decreased. On the other hand, if the blower be in operation with a fairly free outlet, in excess of its capacity area, and that free area be decreased, the pressure produced will immediately rise, thus tending at once to overcome the increased resistance. Therefore, if a certain maximum pressure is known to be required, the fan may be so speeded as to give this at such times as the conditions demand; while at other times, when less pressure or volume of air is required, proper manipulation of the blast gate will economize power.

What is said to be the largest cargo ever carried by a vessel on the Great Lakes was recently loaded on the steamer "Henry W. Rogers," at Escanaba, Michigan, the cargo amounting to 15,080 tons of iron ore.

Economy of Material in Framed Structures. Continued

BY FREDERICK R. HONEY

In an article published at page 270, I assumed the reliability of the formula

$$\tan\theta = \sqrt{\frac{C+T}{T}}$$

in which θ is the value of the angle between the elements c and c_1 which are in compression, and t which is in tension; C and T respectively representing the safe working compression and tensile stresses.

The determination of this formula, which is applicable to any material, is a problem in maxima and minima. The total weight of the structure, or the sum of the weights of the volumes of the elements, is equal to

$$t \times w \times \frac{L}{2}\left(\frac{\sec\theta\ \operatorname{cosec}\theta}{C} + \frac{\cot\theta}{T}\right),$$

in which w = the weight of a cubic inch of the material.

The principles already discussed are applicable to a structure when placed in an inverted position, Fig. 1. The load L acts in the direction of the arrow, and the structure is fastened at a and b. These fastenings simply support the weight, but are not supposed to relieve c of any stress.

The stresses are exchanged for those which have been considered; i.e., those elements t and t' which were formerly in compression are now in tension, and the element c which was in tension is now in compression. This will be evident from an inspection of the strain diagram, Fig. 2. The analysis is precisely the same in the two cases, if we exchange C for T and T for C. The resulting formula for the most economical angle is

$$\tan\theta = \sqrt{\frac{C+T}{C}},$$

in which the denominator of the fraction is C instead of T.

Adhering to the proportion assumed in the first of these articles, i.e., $C = 4.5\ T$,

$$\sqrt{\frac{C+T}{C}} = \sqrt{\frac{4.5+1}{4.5}} = 1.105 = \tan\theta;$$

$\therefore\ \theta = 48$ degrees nearly.

The expression for the total weight of the structure reduces to

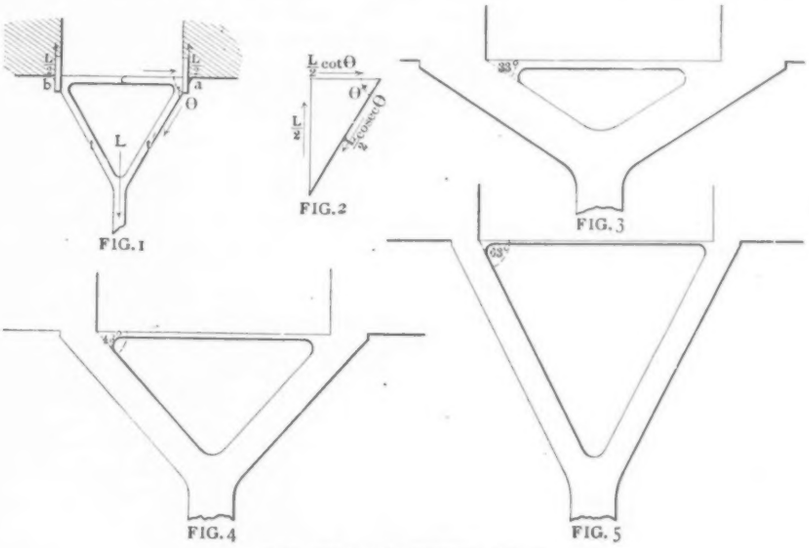
$$C \times \frac{L}{2} \times w\left(\sec\theta\ \operatorname{cosec}\theta + \frac{\cot\theta}{4.5}\right).$$

Since c (the length of the horizontal element), $\frac{L}{2}$, and w are constant, in determining the variations in the weight of the structure as the angle changes in value, we may confine our attention to the variable within the parenthesis,

$$\sec\theta\ \operatorname{cosec}\theta + \frac{\cot\theta}{4.5}.$$

When $\theta = 48$ degrees this expression $= 2.211$. Assuming values of θ greater and less than 48 degrees (more exactly, 47 degrees 52 minutes), we find that the value of the expression increases as the angle increases or diminishes; thus proving the reliability of the formula.

Table 1 exhibits the percentage of wasted material when the angle is increased and diminished beyond its economical value.



THE MOST ECONOMICAL ANGLE

$C = 4.5\ T.$

θ	$\sec\theta \operatorname{cosec}\theta + \frac{\cot\theta}{4.5}$	% wasted material
48°	2.211	0.0
>48° 53°	2.249	$1\frac{7}{10}$
>48° 58°	2.364	$6\frac{9}{10}$
>48° 63°	2.585	$16\frac{9}{10}$
<48° 43°	2.243	$1\frac{4}{10}$
<48° 38°	2.345	6
<48° 33°	2.531	$14\frac{4}{10}$

TABLE 1. WASTE OF MATERIAL BY CHANGING THE ANGLE. CAST IRON.

This table shows that the waste of material increases a little more rapidly with the increase of the angle than with its decrease.

In Figs. 3, 4, and 5 the elements are correctly proportioned for the values of $\theta = 33$, 48 and 63 degrees; it being understood that for the purpose of the illustration, the section area in each case is collected into a rectangular form instead of a T, and that its thickness at right angles to the plane of the paper is uniform.

That dimension which is shown in each figure in the case of the element which is in tension, is determined by the formula

$$\frac{\frac{L}{2}\ \operatorname{cosec}\theta}{T\ (=1)};$$

while the thickness of the element which is in compression is equal to

$$\frac{\frac{L}{2}\ \cot\theta}{C\ (=4.5)}.$$

They are in the proportion

$$\operatorname{cosec}\theta : \frac{\cot\theta}{4.5}.$$

Table 2 gives these values for various angles.

θ	cosec θ	$\frac{\cot\theta}{4.5}$
33°	1.836	0.342
38°	1.624	0.284
43°	1.466	0.238
48°	1.346	0.200
53°	1.252	0.167
58°	1.179	0.139
63°	1.122	0.113

TABLE 2. VALUES OF COSEC θ AND OF $\frac{\cot\theta}{4.5}$

In order to compare the weight of the structure when in an upright and an inverted position, we may proceed as follows:

The constant $t \times w \times \frac{L}{2}$ is the same in both cases, since $t = c$. The other factor in the former case

$$= \frac{\sec\theta\ \operatorname{cosec}\theta}{4.5} + \cot\theta;$$

in the latter it is equal to

$$\sec\theta\ \operatorname{cosec}\theta + \frac{\cot\theta}{4.5}.$$

In the upright position $\theta = 67$ degrees; and

$$\frac{\sec 67^\circ\ \operatorname{cosec} 67^\circ}{4.5} + \cot 67^\circ = 1.042.$$

In the inverted position $\theta = 48$ degrees; and

$$\sec 48^\circ\ \operatorname{cosec} 48^\circ + \frac{\cot 48^\circ}{4.5} = 2.211.$$

Dividing one by the other,

$$\frac{2.211}{1.042} = 2.122,$$

showing that the structure in one position weighs more than twice as much as in the other.

In the illustrations here given, it must be remembered that Figs. 3, 4, and 5 illustrate graphically the amount of material which theory calls for in each case; or the proportion that should exist between the thickness of those elements

which are in tension, and those which are in compression; a consideration of other stresses being purposely omitted as explained in the first paper on this subject.

Table 3 shows the most economical values of θ for cast iron and steel when the structure is in the upright and inverted positions.

		$\tan\theta=\sqrt{\frac{C+T}{T}}$	$\tan\theta=\sqrt{\frac{C+T}{C}}$
Cast Iron	$C=6\ T$	$\theta=69\frac{1}{2}°$	$47\frac{1}{2}°$
Cast Iron	$C=4.5\ T$	67°	48°
Cast Steel	$C=1.5\ T$	$57\frac{1}{2}°$	$52\frac{1}{2}°$
Steel	$C=T$	$54\frac{1}{2}°$	$54\frac{1}{2}°$
Steel	$C=0.8\ T$	$53\frac{1}{2}°$	$56\frac{1}{2}°$

TABLE 3. MOST ECONOMICAL VALUES OF θ.

The Coming Exposition of Safety Devices

We have already (page 288) made an announcement of the Exposition of Safety Devices which the American Institute of Social Service proposes to hold in New York, January 28, February 9, 1907. Gratifying interest is being shown by the inventors and manufacturers of devices for protecting the lives and limbs of workers and of the general public. Applications for space are being filed in the order of their receipt.

Commissioner-general Kohlsatt, alive to the importance of the Exposition to be held in New York, desires to secure it entire for the enrichment of the Jamestown Exposition in 1907.

European coöperation has been generously pledged. The Belgian Minister of Labor has promised a large part of the Belgian Exposition of Safety Devices and Housing. Dr. Muensterberg, perhaps the greatest European authority on public and private charity, has promised to send for the Section of Industrial Hygiene selected and typical exhibits of sanatoria for consumptives and also for drunkards, First Aid to the Injured Stations, of Red Cross Stations, of Workmen's Colonies, and other valuable material. Dr. Hartmann, of the Berlin Museum of Security, will send a splendid collection of photographs and hundreds of scale drawings of safety devices. M. Mamy, Director of the Paris Museum of Security, has already shipped valuable material. Various influential Europeans are coöperating with the Director of the American Institute to secure the best safety devices from the continental manufacturers.

Prominent American also are lending their coöperation as honorary vice-presidents: Grover Cleveland, first vice-president; Hon. Frank W. Higgins, Governor of New York; Hon. Curtis Guild, Jr., Governor of Massachusetts; Hon. E. C. Stokes, Governor of New Jersey; Hon. Henry Roberts, Governor of Connecticut; Hon. C. P. Neill, U. S. Department of Labor, Washington, D. C.; Hon. T. P. Sherman, Labor Commissioner of the State of New York; H. C. Bumpus, Director American Museum of Natural History.

Requests for information regarding space should be made to Dr. William H. Tolman, Director, 287 Fourth Avenue, New York.

Sir Richard Tangye

The following account, by Albert H. Smyth, of the career of the late Sir Richard Tangye appeared in a recent issue of the *Public Ledger* of Philadelphia:

The death in London of Sir Richard Tangye, which was reported last Monday, should not pass unnoticed in America. He was one of the merchant princes of Great Britain, he was an author of international reputation and he was the constant friend of us and of our Government. He was a Cornishman and a member of the Society of Friends. Born to a humble station in life, he attained great wealth and wielded beneficent influence. The story of his career seems more like a romance of American enterprise than the ordinary history of British success. When a poor boy working upon his father's rugged Cornish farm he had, as he was wont to say, the good fortune to break his arm. The surgeon who set it told his father that the lad would perhaps never have the full use of it again, and as he was undersized and lacked the robust health and vigorous strength required for the rough work of the farm it would be wise to give him an education that would open the way to some clerical and sedentary occupation. The advice was taken, and Richard Tangye received such education as could be imparted in a small school in the remotest corner of England. For a while he taught school, but with his first earnings removed to Birmingham to engage in the kind of business for which his mechanical genius and expertness seemed to qualify him. The hydraulic jack, the invention of George and Richard Tangye, laid the substantial basis of the family fortune. When the "Great Eastern" was built it was found impossible to launch the gigantic vessel. The skill of the best engineers of England was exhausted in the futile effort. By a fortunate accident the launching committee entered the obscure little shop of "Tangye Brothers, Engineers," who confidently expressed their ability to perform the task. It was the beginning of their great success, and today the Cornwall Works cover several acres of land in the city of Birmingham, and have thousands of men on the pay roll. It is a saying at the works, "We launched the 'Great Eastern,' and she launched us."

Richard Tangye was knighted by the late Queen, not for political reasons, for he was always a thorough and uncompromising Liberal, but for his munificent generosity to Birmingham. He gave freely of his brains and his fortune to the Liberal cause in English politics, and was a constant friend and adviser of Lord Rosebery. During our Civil War he espoused the Northern side, and retained at all times, in victory and adversity, a conviction of the righteousness and the ultimate triumph of the Union.

When the unhappy disruption of the Liberal party by Gladstone's fatal policy occurred and Birmingham was swept from its ancient political anchorage, Sir Richard Tangye founded and conducted a newspaper, the *Argus*, to supply the place made vacant by the defection of the *Post*.

His hobby was the collection of documents and relics illustrative of the career of Oliver Cromwell. This collection, which is of great size and extraordinary value, is now at his summer home, "Glendorgal," near Neuquay, beside the Cornish sea. It includes a remarkable array of portraits, coins, medals and pamphlets, the original manuscript appraisement of the personal estate of King Charles I made by order of Cromwell, the skull of Richard Brandon, the headsman who executed King Charles, and a great assembly of other souvenirs.

He published a few years ago a history of Cromwell, entitled "The Two Protectors: Oliver and Richard," which is one of the best studies from original documents of the great civil war. He frequently printed, privately, neat little volumes of "Tales of a Grandfather" (with apologies to Sir Walter Scott), dedicated to his grandchildren, containing reminiscences of Cornish life and folklore and interesting bits of personal history. They were intended only for circulation among his friends. As a man of business he won his way by strict integrity and unvarying industry and frugality. As a public man he was the soul of truth and honor. In private life he was gentle and generous, a delightful host and a firm friend—a perfect example of the English gentleman.

Report on Fuel-Testing Plant

We are informed that the preliminary report on the operations of the fuel-testing plant of the United States Geological Survey at St. Louis, Mo., for 1905, is ready for distribution, and that this report, which is known as "Bulletin No. 290," may be obtained gratis upon application to the Congressman from the applicant's district, or to the Director of the United States Geological Survey, Washington, D. C.

The Cincinnati Milling Machine Company issues a pamphlet entitled "Examples of Rapid Milling," which, although they state it is used as a supplement to their complete milling-machine catalog, is yet not in reality a catalog, but a book illustrating and describing certain typical jobs of fast milling, done upon their machine, and which very well show the capacity of the modern miller.

CORRESPONDENCE

Discussing Phases of Machine Design and Construction

Making Accurate Cam Formers on the Milling Machine

Artebe's letter at page 488 regarding the process of making formers for precision cams such as are used in watch machinery has revived the discussion on cams and I would like to give a few points which I consider of importance and also the method of milling the formers for cams such as those used in machine-tool work where the motion required is of a constant nature and where great accuracy is required.

The milling of formers or cylindrical cams is done by the ordinary process of spiral milling with the exception that it is best to use the vertical spindle milling attachment when one is available as it places the cutter in a much more convenient position than does the method of holding the cutter in the horizontal position. Fig. 1 shows a side elevation of the spiral head, the change gears and the end of the table and lead screw necessary for a clear impression of how this work is accomplished. The work is placed on an arbor and is gripped in the chuck at the same time, making the chance of vibration very slight.

The majority of the cams for this class of work are made to give a slow motion forward while the tool is feeding, a quick return motion returning the tool to the former position. The quick return motion can be made harmonic although when this is done the cam cannot be formed by the direct process of spiral milling which is the case for all constant motions. For the sake of clearness we will here consider that all motions are constant. For cams giving two motions only the spirals would be made opposite in direction, and in most cases different in lead.

The method of going about the job is usually expressed in degrees and may be called the "extent of travel." The next thing to do is to lay out the extent of travel on the periphery of the blank employing a center in the milling machine spindle and revolving the work the correct amount by the aid of the index crank. When this is done we are ready to proceed. The pitch of the spiral is easily found by taking the extent of travel in degrees and dividing 360 by that number, multiplying the quotient by the length of the motion. For example, the cam causes the roll to advance two inches on revolving 150 degrees; the lead of the spiral is

$$\frac{360}{150} \times 2 = 4.8 \text{ inches.}$$

By gearing the machine to give this lead we may, by proceeding as in ordinary spiral milling, produce the desired shape on the former. The cutter used should be approximately the same diameter as the roll to be used. The effect of the diameter of cutter only asserts itself at the turn in the shape or more clearly at the

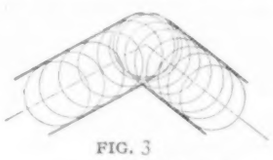


FIG. 3
Showing effect of sharp turns

FIG. 4
Turn modified with small arc

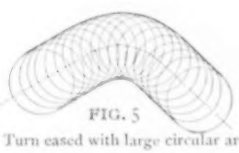


FIG. 5
Turn eased with large circular arc

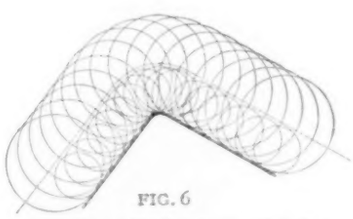


FIG. 6
Effect of having Cutter and Roll of different diameters

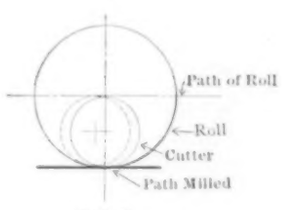


FIG. 7
Effect of Eccentricity

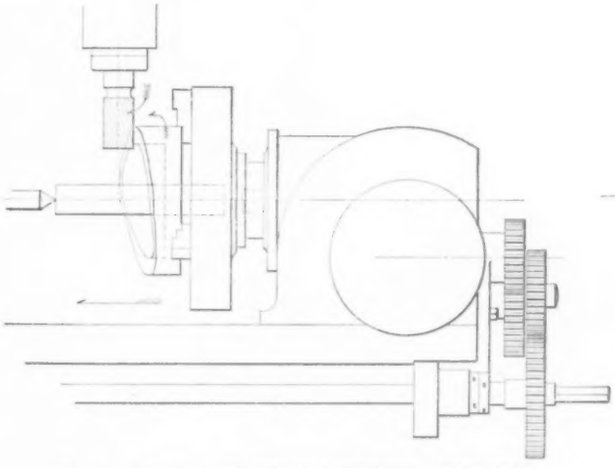


FIG. 1. MILLING CYLINDRICAL FORMERS—ELEVATION

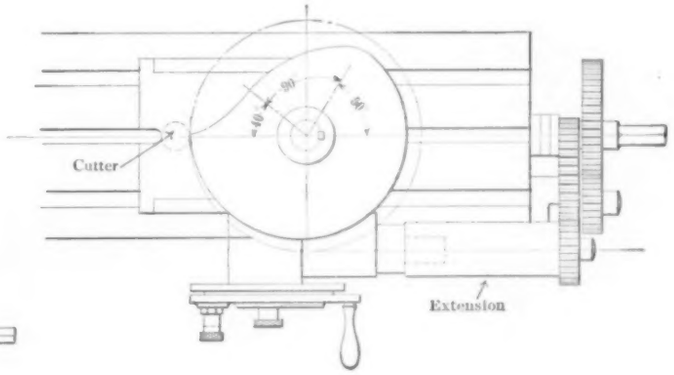


FIG. 2. MILLING PLATE FORMERS—PLAN

junction of the two spirals. When the proper spiral can be obtained by means of the gears at hand much time will be saved and better results obtained than would be possible when trying to work to a line.

Formers for plate cams can be milled in a similar manner, the only difference being that the spiral head spindle is swiveled to the vertical position. In order to use this method on this style of cam the head will have to be provided with an extension to the worm gear shaft as the head cannot be brought under the spindle of the machine as usually set up. The use of the extension and the method of setting up are shown in Fig. 2. The cam shown in this figure has three different spirals and a dwell. The blank is marked off as already explained and as shown in Fig. 2. The ease with which the work is done will be striking to those who have worked out a cam on a shaper as near as possible to a line and then finished it up with a file. This method eliminates the file and the eye strain also, and relieves the mind as the possibility of running out is very slight. This method has been used in cases where cams made with ordinary methods have failed and it has acomplished results that have far exceeded expectations.

In designing cams we should not only look to the results as to motion but to wear and tear, which can be greatly diminished by proper care in design. The wearing point on a cam is always at the turn, that is at the change of motion from one direction to another. The change should never be abrupt as when such is the case lost motion is always present as shown in Fig. 3, which represents the progress of the roll in the path desired (which path it is obvious is not obtained in practice) which is on two straight lines at an angle with each other and joining in an abrupt angle. It will be noticed that the roll leaves the inner side of the groove, allowing a back lash. This is caused by the cutter cutting away that portion of the groove that interferes with its progress and can only be remedied by making the junction of the two paths tangent to a circular arc whose radius must equal the radius of the roll. This has been done in Fig. 4. The backlash has been eliminated but the inner side of the groove has a sharp angle junction which is subject to great wear and would soon be worn away. A rule that will usually be found to work well is to make the radius of the tangent arc equal to the diameter of the roll as shown in Fig. 5. This gives a generous round at the junction of the two paths, adding greatly to the wearing qualities of the cam and also to the smoothness of action.

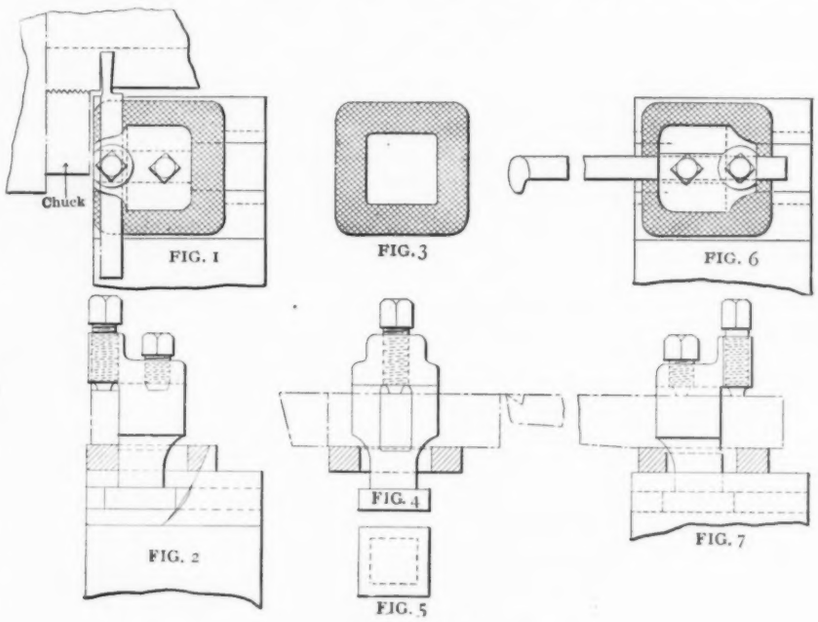
In milling the former it is best to have the cutter as near like the roll in diameter as possible, but in the profile milling of the cam when the guiding roll is used the cuttter may be much smaller than the roll and still give good results, in fact it is better so as the effect of a slight eccentricity of roll and cutter is much less. That the size of the cutter, so long as it is smaller than the roll, has no effect on the path milled is shown in Fig. 6 where the cutter is seen to reproduce the path which the roll follows. The effect of eccentricity of roll and cutter is shown in Fig. 7, where the full lines show the proper relative positions, the dotted circle showing the cutter in an eccentric position rather exaggerated, but showing the slight effect even when so. The larger the cutter becomes in comparison with the roll the greater does the effect of eccentricity of the cutter and roll show up. The smaller the cutter the better as a much smoother surface is obtained by small cutters since they can be run at much higher speed removing less per tooth than is possible with the larger cutters.

DYNAMIC.

An Improved Tool Post

The illustration shows a lathe tool post that possesses decided superiority over any now in common use.

Figs. 1 and 2 show a square-nose tool



A TOOL POST

firmly held within 1/16 inch of the chuck jaws. Fig. 3 is the tool-post ring.

Figs. 4 and 5 show the square end of the tool post a good sliding fit in the tool slide, permitting any of the four sides to face the work.

Figs. 6 and 7 show a boring tool that cannot slip.

The advantage shown in Fig. 1 where a parting tool could work within 1/16 inch of the chuck jaw is quite sufficient even alone to recommend the tool post.

I have seen many parting tools, square-nose and thread tools, that had been broken simply because the tilting gib caused the tool to lose its side clearance; these tools were all of the off-set type.

Offset tools are a poor make-shift and should have no place in the up-to-date shop; nor should the tilting gib.

F. RATTEK.

"Tempering Novo Steel with Cyanide"

J. B. F., writing at page 486 on this subject, does not claim any benefit from the general use of cyanide on tool steel. He says it can *do no harm*, and that it only cleans the article as the water gets to it quickly and evenly. I must confess that I cannot see the necessity of using cyanide for this purpose, neither does the article need cleaning *quickly* and *evenly*. It just needs to be clean, which it will be if heated in a clean charcoal fire, or a gas furnace, not overheated and quenched in clean lard oil or water.

Regarding the manufacturer with a world-wide reputation who uses cyanide almost entirely, I presume J. F. B. knows whereof he speaks, and I will not dispute him, but I will venture to say that if he uses the best grade of tool steel in his cutters and uses no cyanide, that the tools will need grinding less frequently. This also possibly explains why some of our cutters break so easily.

In conclusion I wish to say to those interested in the hardening of tool steel as used in dies and miscellaneous tools in our metal-working factories, that cyanide *does* hurt tool steel, especially when above 75 carbon. If the steel is heated to the proper hardening heat, the application of cyanide forms a hard scale on the surface of the tool, leaving it brittle and harder than the steel was intended to harden for the given carbon. When the temper is

drawn, this scale or crust still remains, and I have seen dies crumble when hardened this way that would last indefinitely when made of the same steel and hardened without using cyanide. If J. F. B. will try using a good grade of steel, of say 85 to 90 carbon, for general purposes, *heat slowly*, and dip on a rising temperature in oil, clear water, or brine, as his work demands, and use cyanide only when his steel will harden no other way (as sometimes happens), I am sure he will get better results and will have fewer tools worn out before their time. COMMON SENSE.

Making Drill Jigs

We had a large number of drill jigs to make that could not be handled to advantage on any of the regular machines in the shop, so I decided to rig up a No. 5 Becker-Brainard vertical miller for boring the jigs.

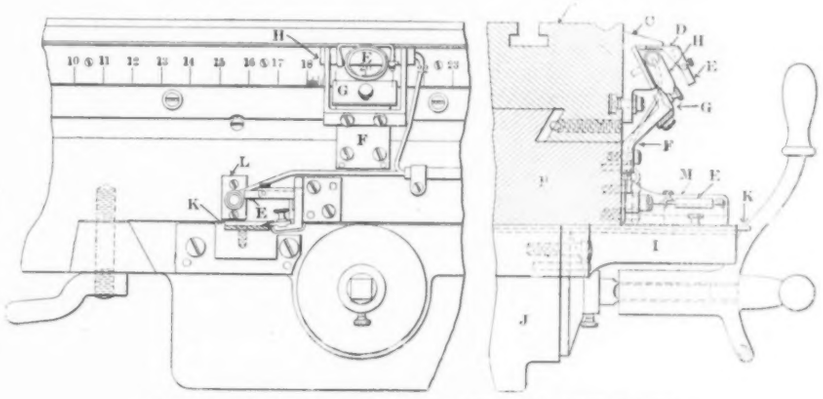
A is the table on which the work is clamped, *B* is the cross slide, *C* is the scale guard, made of machine steel. It extends the full length of the table. The scale is secured to this guard at the most desirable angle. The overhanging ledge affords protection for the scale, lamp and vernier plate. The small T-slot that was formerly used for the feed stop is utilized to hold the scale guard. Directly under the ledge, a piece is fastened, forming a slot, into which the magnifying glass holder *D* is slid. It is so arranged that the glass may be used elsewhere, or locked away when the machine is not in use. The glasses are swung on trunnions, and can be set at any angle by the small screw.

The bracket *F* fastened to the cross slide *B* supports the vernier plate *G*, and the lamp frame and tube *H* also. The lower scale for the cross slide is embedded in the bracket *I* and knee *J*, and is protected by a loose slide piece *K*. The lamp tube is held by the plate *L*, and is supported at the outer end by the vernier bracket *M*. This is broken in the illustration to show the magnifying glass in position. The lower glass is mounted in the same way as the upper one.

Small incandescent lamps, 7/16 inch diameter by 2 inches long, are inserted in the tubes, the tube being slotted to direct a ray of light on the vernier plates only. The wires from the lamps run through the tube—part of which is shown—to a switch fastened to the side of the knee.

The scales are Brown & Sharpe make, graduated to 50ths of an inch with a vernier reading to 0.001. The table scale is about 42 inches long, and the cross-slide scale about 16 inches long, which gives a large range for jig work. The feed mechanism for the table and cross slide has been removed, not being required for this class of work.

The set of tools used with the machine consists of a reducing bushing, hardened and ground to receive a set of collets 3/16 to 5/8 inch, a set of sizing reamers, to be held in the spring collets, a set of Morse taper-drill sockets, Nos. 1 to 4, an assorted set of boring bars, a center, a countersink and a feeler. All tools are held in place by the draw bar through the spindle, to the top end of which is fitted a hand wheel which greatly facilitates the handling of tools. The feeler is made about six inches long, hardened and ground to 7/16 inch diameter for about two inches of its length, and the rest of it is ground to 0.4 inch diameter. It is used to line up a job, also to locate the holes, registering from finished surfaces, half the diameter of the feeler being added to or subtracted from the reading, as the case may require.



VERTICAL MILLER FITTED FOR DRILLING AND BORING JIGS

If the feeler can be brought up to the straight surfaces in a jig to be registered from, it is not necessary to lay off the jig at all. The operator draws up a working chart, giving the location of the holes in decimals, so that the shifting can be done without any delay. If the feeler cannot be used, we simply put right-angled cross lines on the job, and use the center which is ground true, and run along the line, trying at different points and take a reading, then run along the cross line taking the reading; coming back to both readings brings the center directly over the intersection of the lines, regardless whether the intersection is seen or not. The location of all other holes on the same side is computed from the intersection reading. The countersink is first used, followed up by a short drill 1/32 inch smaller than the finished size, then the boring bar which bores within 0.002 of finished size, and finally the sizing reamer, which is very slightly relieved. It is remarkable the way these reamers hold out. To my knowledge, a half-inch reamer has been used on about 500 holes in steel and cast iron, and still holds its size.

All holes set on angle lines are computed with the use of the sine and tangent tables. This in itself is a great improvement over the old method of using the faulty protractor. Holes on circular lines and different radii are bored on a circular table that is supplied with the vertical miller.

This machine has been in use a little over a year, and it gave such good results that another smaller machine was purchased, and equipped somewhat in the same way as the larger one, to take care of the smaller work. In conclusion I will say that it has brought about a decided change for the better in this branch of the trade. The present operator of the larger machine, who does all his own figuring, is a young man not yet twenty years of age, and is far from being a full-fledged machine. W. A.

Starting a Shop — Three Successful Experiences

Entropy's suggestions and advice at page 412 on "Starting a Shop" are all right, and I for one hope that more of them will find their way from his pen to the pages of the AMERICAN MACHINIST. The subject is one which, like the machinist trade, can never be completely mastered in all its details by one person, although he may be preëminently successful under his particular conditions.

I have in mind a young French Canadian machinist who started a repair shop with a 26-inch lathe and a 4-horse-power gas engine. The town was a poor enough location for such an enterprise, being small, with no factories, etc., worth considering, but several large tow-boats stopped there for wood occasionally, and, as luck would have it, a breakdown occurred which my acquaintance was to repair; this led to the boats lying up there for the winter, and having their machinery overhauled by this shop.

Now there are half a dozen lathes, two planers, and in fact a neat little repair shop, which has yearly sawmill repair contracts running into the thousands.

To many this would not mean either wealth or happiness; but to this uneducated—except at his trade—machinist, his little shop with its profit ranging from two to three thousand dollars per year is doubtless all or nearly all that can be desired; certainly it is ahead of running someone else's lathe for $12 per week.

Thirty years ago two ordinary machinists started a small general shop in partnership; they prospered, and when the

business was worth about $1500, one of them received the offer of a position with a big firm at $4000 per year, which he accepted, although urged not to by his partner. In three years the large firm had failed, and today the partner who stuck by the business would, if I gave his name, be recognized as the largest machine-tool builder in a certain section of the country. The other partner is superintending his own little shop in overalls, doubtless often regretting that he did not stick by the ship.

Very recently a case of fortune favoring the brave came to my notice. About a year ago, when the first rush was on for the Cobalt silver district in northern Ontario, a young machinist from our town borrowed every cent he could lay his hands on, bought a lathe, small steam-power outfit, portable forge, and paid excessive freight rates on the lot to get them up there in a hurry. In a month he had paid off every cent he owed, and today is practically well off. NERALCM.

Starting a Shop—Working Rubber and Paper—Apprentice System — Boring Bars and Cutters

Entropy's remarks at page 412, on starting a shop, are very good, especially as to money matters.

I, like many others, have a business bee in my bonnet, and hope to be able to start in for myself in the near future, and any further remarks made by Entropy or others, would be highly appreciated.

At page 440, William Clark gives a few good pointers on turning and boring paper and rubber. I use the same method, except that I use the regular tool steel dressed to a similar shape at the cutting end. I don't quite agree with Mr. Clark in the speed nor the depth of cut. His assertion that the lathe can be run at the fastest speed of the lathe is very indefinite, as some lathes are speeded much faster than others. However, in the majority of cases, that would do; but I think that 900 to 1000 feet per minute would be a little more definite. Again, as to the depth of cut, I have frequently taken as much as 5/16 inch at a time on large frictions.

The apprenticeship question has been pretty thoroughly threshed over, but no one has advanced a remedy for the existing evil, nor can I advance any theory either, except that the boy will have to fight his way through. If he has the right stuff in him, he will keep his eyes and ears open for pointers, and push himself forward into the class of work that will give him the desired experience. He must also study his trade both in the shop and at home.

How many apprentices of today spend a half hour in studying mechanical books in the evening? It is safe to say not one in twenty.

How often do we see machinists of today go to a vise to do some little job, and are not their efforts with the hammer, chisel and file ludicrous? Why can't they, when chipping a lump off a casting in the machine, make a nice, smooth, straight job of it? Again, in filing a job in the lathe, they have an excellent chance to learn to "run a file straight."

Apprentices, for pity's sake don't choke your hammer; that is one of the most common evils I have observed.

Take the size of hammer that suits your arm best for general purposes. Have a handle 16 inches long; grasp it so that about ¾ inch projects past the hand. Hold it as loose as you can, even to the extent of letting it slip a little in the hand. Let the grip be with the two middle fingers, the others merely guiding the stroke. Let the hammer oscillate in the hand as far as possible and swing it a little to the right of the shoulder; drop it as far back as possible without distorting the body, now swing with a sharp, smooth blow. Keep this up for a while and you will soon acquire a motion that will be easy and graceful.

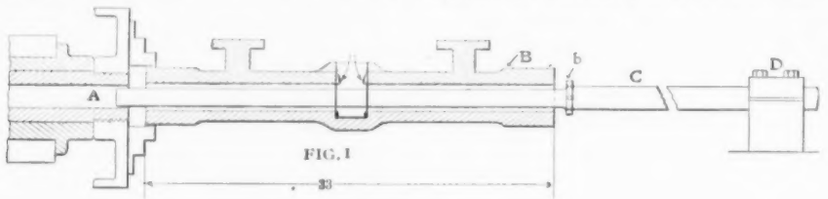


FIG. 1

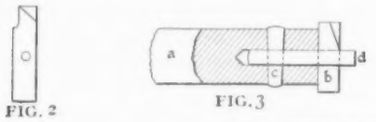


FIG. 3

FIG. 4

FIG. 2

THE BORING TOOLS

Speaking of boring bars and cutters reminds me of a job I had a few years ago in a Western city.

The foreman gave me an order for 50 mining-car axles as shown at Fig. 1. They were gray iron, 33 inches long, cored 2 inches and were to be bored 2¼ inches.

We first turned them all to size on the ends and faced them. Next we took a piece of cold-rolled shaft 2 inches diameter and turned it down to 1¾ inches a sufficient length to reach through the casting into a bushing in the hollow spindle of the lathe before the cutter *b* comes in contact with the work, also to allow cutter *b* to go through the axle before it would strike against bar holder *D*, which is bolted to the tool rest.

This holder was bored true with a small bar on the centers, so all that was necessary to boring it in perfect alinement was to bolt it down tight, move it till the center in the bar came to the center in the tailstock. As will be seen, we caught one end in the chuck; the other end ran in the steady-rest at *B*. The bar is then fastened in the block *D* and adjusted. The cutter *b* is put in place and tightened; then we are ready to go to work.

By this method the job was bored the entire length with one setting. The cutter *b* is merely a piece of ⅝-inch round Stubs steel with a countersink in the center for a ½-inch pointed set screw.

Fig. 2 is an enlarged sketch of the tool which was turned one 2 3/16 inches and one 2¼ inches. By running these two cutters we had a perfect hole.

Fig. 3 is a cross-sectional sketch of another tool I have frequently made use of.

A is a stock which may be fitted to the lathe spindle or to the spindle of the drill press, the one I used being 3 inches diameter. It would bore a hole from 3½ inches to 5 inches nicely.

Simply drill a 1¼-inch hole to take the spindle *d*, then make the cutter *b* the size you want, slip through the slot in *d*, press the spindle home, drive the key *e*, and go ahead. Fig. 4 is another view showing the support the tool has, also the clearance for chips. I have used this tool for end milling and it will discount any other tool for removing stock and is an excellent tool for the jobbing shop where a great variety of work is called for.

A. GREASER.

Large Ventilating Fans

One of the specialties of the Allis-Chalmers Company is the construction of large ventilating fans of diameters from 12 to 35 feet, of the double-intake center-draft type. The fans are built up, with sheet-steel blades, carried by sheet-steel arms, which latter are clamped between two cast-iron centers. At the ends of the blades are what might be called revolving housings, being a series of steel plates inclosing the sides of the fans from the periphery of the intake to the periphery of the outside of the blades. The sheet-steel construction includes the use of angle irons and tie rods so that the whole revolving structure is well braced, making it strong and rigid. The inclosing of the fan by plates revolving with it has the effect of reducing friction and preventing loss of air due to clearance between the fan and the sides of the fixed housing. The fan is usually secured to a hammered iron shaft by heavy keys. It may be driven either by belting or by direct connection with the engine or motor.

ALUNDUM, THE NEW ABRASIVE

How a Substance Nearly as Hard as Diamond is Made by the Power of Niagara Falls — Why it is a Valuable Material for Grinding-Wheels *

No more remarkable advance in mechanical lines has taken place in modern times than the development of grinding. The field of the old grindstone was limited, and the sharpening of edged tools was almost its only use.

The introduction of the emery-wheel, however, made grinding a very important operation. The emery-wheel has not only rapidly replaced the grindstone, but in many operations the work of the cold-chisel, the lathe-tool, the file, and other steel-cutting tools is now done more efficiently by grinding.

Before the invention of the electric furnace, artificial abrasives suitable for grinding-wheels were unknown. Wheel manufacturers necessarily depended upon natural products, chiefly corundum and emery. As emery occurs in considerable quantities in various parts of the world, it came to be recognized and used as the chief raw material for grinding-wheels and other products employed in grinding metals. On this account the modern grinding-wheel made of any abrasive is popularly known as the "emery-wheel."

The Norton Company has during the past few years been operating an electric furnace plant at Niagara Falls, in which has been developed and brought out a superior abrasive, alundum.

The introduction of alundum in the field of grinding has been remarkably successful and rapid. The requisites sought for and attained in this abrasive are extreme hardness and sharpness, combined with uniformity and proper temper.

THE RAW MATERIAL AND THE ELECTRIC FURNACE

The process of making alundum consists in taking the purest amorphous oxide of aluminum found in nature, and known as the mineral bauxite, purifying and melting it in the electric furnace in a large, homogenous bath or fluid mass. Upon cooling, this molten fluid solidifies and crystallizes in solid masses of alundum of great purity and absolute uniformity throughout.

Bauxite, the raw material from which alundum is made, is the purest naturally occurring amorphous oxide of aluminum known.† This mineral was originally found at Baux, France, from which it derives its name, but purer forms are now obtainable in the United States. The best quality only is used in the manufacture of alundum, and in its preparation practically all impurities are removed.

The bauxite is heated in large preliminary heating furnaces to drive off the combined water, and is then melted directly in electric furnaces of special design. Bauxite was considered infusible until the invention of this process, no heat of combustion being able to melt it.

Eleven electric furnaces have been installed, each capable of producing three tons of alundum every twenty-four hours. The electric power necessary is produced by the Falls of Niagara.

The temperature at which the furnace charge melts in one homogeneous mass is above the limit at which temperatures are measured by any means known to science, and is variously estimated between 6000 and 7000 degrees Fahrenheit.

The operation of these furnaces and the composition of the molten bath is under the control of the furnace operative. Exact quality and uniformity which are so important in steel manufacture, are fully as important in the manufacture of alundum. The highest grades of steel are now being made in electric furnaces similar in design to the alundum furnace, because impurities can be removed at the high temperatures obtained by the electric arc, and the quality of the molten bath uniformly maintained. In the alundum furnace both the purity and uniformity of the alundum are assured. Each step in the process is under the close supervision of expert chemists, who are constantly directing and following the work by careful analyses.

THE PRODUCT OF THE FURNACE AND ITS SUBSEQUENT TREATMENT

The large masses of molten bauxite are allowed to cool and crystallize in ingots of purified crystalline alundum. Beautiful crystals are found in the center of these masses, showing nearly all the variety of colors found in the ruby and sapphire, of which alundum is the commercial, artificial product. The rarer colors of light pink, blue and purple found in the rarer oriental gems are sometimes noticed in small crystals. The ingots of alundum are broken up into small pieces by means of powerful crushers. It is then passed through series of rolls to reduce it to the various sizes of grain, which are finally separated by passing over sieves of different mesh to prepare it for manufacture into grinding-wheels, rubbing and sharpening stones, etc.

The solid alundum, while resembling the purest natural corundum in chemical composition, has the remarkable quality of being considerably harder than the natural product. This is due to the perfectly fluid condition to which the mass is melted, the control of its composition, the rate and method of its cooling and crystallization by which it receives its temper, the absence of water in combination (which almost invariably exists in natural corundum), and the pure and even state in which the fluid mass crystallizes.

QUALITIES OF AN ABRASIVE

The necessary requisites for the most efficient abrasive for grinding-wheels are: 1. Sharpness; 2. Hardness; 3. Right temper; 4. Uniformity; 5. Abundant supply.

To have sharpness in order to obtain the most satisfactory results—so far as rapid and continued cutting is concerned—a peculiar quality is necessary. There must be a fracture which will give a number of sharp-cutting points. This is obtained in alundum.

SCALE OF HARDNESS

In the matter of hardness, the recognized standard is the diamond, which is No. 10 in the scale of hardness; nothing that man has yet discovered or made equals the diamond in hardness. The term "hardness" is comparative. The hardness of a mineral being ascertained by its ability to scratch another mineral of a known degree of hardness, or to be scratched by such a mineral.

Pure crystalline corundum, represented by the best sapphire or ruby, has always been the standard of No. 9 in the scale of hardness. This is readily scratched by alundum; in fact, alundum powder is used for cutting and drilling rubies and sapphires for watch jewels, etc. After numerous careful tests, comparing alundum grains with other abrasive grains, including the diamond, alundum is found to exceed 9½ in the scale of hardness where the diamond is 10.

By "temper" is meant its strength of grain and the character of its fracture under grinding pressure. An alundum grain is remarkably tough, and will stand great pressure before breaking; but when it does break down, it breaks with a sharp, crisp fracture, giving a fresh, keen-cutting edge. This is the most important quailty in an abrasive.

In respect of purity and uniformity alundum stands very high. Purity, besides resulting in greater hardness and better temper, is necessary in the bonding of the grain into wheels, in order to secure accurate and uniform results, and uniformity is necessary to secure constant efficiency and accuracy of grade and temper in a wheel, so that wheels can be accurately duplicated at any time and maintain their standard of work.

Uniformity is one of the most important requisites in an abrasive. The ability to duplicate a grinding wheel is essen-

(*Continued at page 619.*)

*The information contained in this article is furnished by the Norton Company. We gladly publish it in answer to numerous requests for information regarding the new material.

†"The Mineral Industry during 1904" (Vol. XIII) contains an article on bauxite, giving sample analyses and other information.—Ed.

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Laws of Social Statics and Dynamics

We have at various times called attention to the fact that, as we see it, builders of machinery are under peculiar obligations to pay some attention to sociological and economic matters. Those of us who are in any way connected with the production of machinery are to that extent responsible for the work which is bringing about the most profound changes in the manner of life of the whole human family. We cause to be valueless that which before had value; we make valuable that which before was worthless. We stimulate or retard the migration of population, both generally and with respect to specific localities; we cause the employment of many men in some places at new work, and cause work to cease in other places and men to be thrown out of employment. Though the net result of it all is of course for the better, our living depends, after all, upon the willingness of other men to do new things, and to do old things in new ways, and troubles for individuals must inevitably result.

No class of men in all the world exert a fraction of the influence upon the human family that is exerted by those who invent, design and build machinery. It seems, therefore, peculiarly appropriate that such men should give some attention to the problems of what it is all about—should go beyond the question of its immediate effect upon personal well being and consider its effect upon social well being.

Especially have we sought to induce our readers to clearly distinguish between large, competitive, mayhap prosperous, mayhap incorporated, business and manufacturing enterprises on the one hand and monopolies on the other—to realize that the good or evil of an enterprise does not depend upon its magnitude, upon the wealth of its owners, nor the rate of dividends, but primarily upon whether or not it is a real monopoly, i.e., upon whether or not other men equally skilled and with the necessary capital (which can nearly always be obtained upon easy terms) can freely engage in the same line of business and compete upon equal, or approximately equal, terms.

Apropos of all this we note in the address of Dr. Humphreys at the dedicatory exercises of the new engineering laboratory of the University of Pennsylvania, a quotation from an address by Thomas Huxley delivered in 1880 upon the occasion of the opening of the technical college in Leeds. Huxley's words are well worth pondering, and it seems to us that their significance and importance are much more plainly apparent today than at the time when they were spoken. He said:

"It is not beside the mark to remind you that the prosperity of industry depends not merely upon the improvement of manufacturing processes, not merely upon the ennobling of the individual character, but upon the third condition, namely, a clear understanding of the conditions of social life on the part of both the capitalist and the operative, and their agreement upon common principles of social action. They must learn that social phenomena are as much the expression of natural laws as any others; that no social arrangements can be permanent unless they harmonize with the requirements of social statics and dynamics; and that, in the nature of things, there is an arbiter whose decisions execute themselves.

"But this knowledge is only to be obtained by the application of the methods of investigation adopted in physical researches to the investigation of the phenomena of society. Hence, I confess, I should like to see one addition made to the excellent scheme of education propounded for the college, in the shape of provision for teaching Sociology. For though we are all agreed that party politics are to have no place in the instruction of the college; yet in this country, practically governed as it is now by universal suffrage, every man who does his duty must exercise political functions. And, if the evils which are inseparable from the good of political liberty are to be checked, if the perpetual oscillation of nations between anarchy and despotism is to be replaced by the steady march of self-restraining freedom, it will be because men will gradually bring themselves to deal with political as they now deal with scientific questions; to be as ashamed of undue haste and partisan prejudice in the one case as in the other; and to believe that the machinery of society is at least as delicate as that of the spinning-jenny, and as little likely to be improved by the meddling of those who have not taken the trouble to master the principles of its action."

Especial attention may be called to the passage in this quotation setting forth the great Huxley's belief that "social phenomena are as much the expression of natural laws as any others," and the obvious deduction from this that "no social arrangements can be permanent unless they harmonize with the requirements of social statics and dynamics; and that, in the nature of things, there is an arbiter whose decisions execute themselves." This means that Huxley believed in the reign of natural law in social and economic matters as well as in physical, and that human laws, customs or usages out of harmony with such higher laws always and inevitably bring their own penalties.

Engineers and mechanics, who so constantly are reminded that they must work in harmony with natural physical laws, or make no progress, will find it easy, as evidently Huxley found it, to perceive that there are also immutable, natural laws that apply to social phenomena and

that disobedience of such laws just as surely brings the appropriate penalties.

Standards and Standard Practice

Discussing the subject of "standardization in civil and mechanical engineering," our contemporary, the *Engineering Record*, begins with the rather startling statement that "it would be interesting to know if the advocates of standards for all purposes have ever reflected that a rigid adherence to their fetich would have left us with the Concord stage and clipper ship as the best facilities for transportation, and Puritanic blue laws as a code of municipal conduct." When we read further into our contemporary's article, however, we find that what it has in mind as constituting standards is the regular approved practice in engineering—an entirely different thing from the standardization which is usually advocated by mechanical engineers. Standards, as we understand them generally in mechanical engineering, consist of the reduction to uniformity of certain parts of machines, so that they may be either economically manufactured or so that they may readily be connected or worked with corresponding complementary standard parts of other machines. For instance, there are standard pipe flanges so arranged that any two pipe flanges of the same nominal size can be used together. There are standard pipe threads; there are standard taper shanks; standards for the size of crankshafts of engines and of generator shafts which are to be connected together, all of which are vitally necessary to the progress of mechanical-engineering work, and which in no way, or at least very slightly, interfere with the putting out of new designs or departures from what has been adopted as regular practice. The "standard practice"; that is to say, the generally approved designs which our contemporary seems to regret as interfering with progress, are, so far as we know, not much worshiped as a fetich or in any other way by mechanical engineers, and certainly the vast progress that has been made in all lines of machine design and of mechanical engineering during the past ten years would seem to indicate that such standards are very little respected. But standards such as we have enumerated above are vitally necessary to this progress; they are the standards which many engineers and designers do worship, not as a fetich, but as one of the greatest aids to the successful practice of the art of machine design and construction.

(Continued from page 617)

tial to efficient results from its use. In grinding-wheels the abrasive grain of given size is bonded together to produce a certain grade or temper for a certain kind of work. This means that the bond, which holds the grains together, must be harder or softer, according to the particular work required of the wheel. Different grades are required for different materials to be ground; cast iron, steel, brass, glass, bone, leather, wood and other substances demand wheels of special grade which must be duplicated to make the grinding operation continuously efficient.

It is for this most important reason that great stress is placed on evenness in quality of the abrasive itself. Grades cannot be duplicated accurately without having a known and dependable factor in the uniformity of the material composing the wheel; and this important requisite is in high degree found in alundum.

New Publications

"An Elementary Text Book on Machine Design." By Chas. L. Griffin. 183 6½x9½-inch pages with 82 illustrations. American School of Correspondence, Chicago. Price, $2.

As stated in the preface this book is not offered in competition with the many treatises on its subject, but rather as preparatory and auxiliary to them. The author believes that the chief difficulties of the student spring from his lack of ability to attack a general problem and hence, instead of dividing his book into a series of chapters dealing with various machine elements, he devotes the first part of it to an explanation of just how a designer goes at the designing of a simple machine, giving his preliminary rough sketches, his calculations, reproduced in fac simile, and his final detail drawings. All this is excellent and we are convinced it is just what the average beginner needs. Part II deals with the leading machine elements and is more after the conventional method than is Part I. The formulas given are always based on analysis and never on rules of thumb, special emphasis being, however, placed on the modifications of theoretical results which are brought about by practical considerations.

"Henley's Encyclopedia of Practical Engineering and Allied Trades." Edited by Joseph G. Horner. Six volumes of about 500 7½x9¾-inch pages each; fully illustrated. The Norman W. Henley Publishing Company, New York. Price per volume $6, per set $25.

It is not easy to form an accurate idea of the merits of an encyclopedia which, in this respect, is like an engineer's pocket book, but more so. Examination of the two volumes so far published indicates, however, a great degree of care and discrimination in the work. The editor points out in the preface that the reason for the popularity of encyclopedias of a literary and scientific cast—the increasing tendency toward specialization and the desire of the specialist for comprehensive, but brief presentations of subjects of which he can hope to have a limited knowledge only—applies with special force to engineering as a whole and that there is hence scope for an encyclopedia of engineering. The treatment is popular to the extent that, with rare exceptions, it is not mathematical and the volumes are thus readable by anyone. The illustrations are numerous, excellent and modern and the subject matter is terse and comprehensive. While civil engineering subjects receive due consideration mechanical subjects form the most of the matter presented. The entire publication is ambitious and praiseworthy and deserves to be well received.

Meeting of the Society for the Promotion of Industrial Education

The first meeting of the new Society for the Promotion of Industrial Education will be held in Cooper Union, Friday, November 16, at 8 p.m. It will be a public meeting. Prof. Milton Higgins will introduce Dr. Henry S. Pritchett, who will preside and there will be addresses by Frederick P. Fish, president of the American Telephone and Telegraph Company, James Addams, Hull House, Chicago; Dr. Micholas Murray Butler, of Columbia University; Frank P. Sargent and Alfred Mosely.

Personal

Hub. Bernartz, formerly draftsman with the New Haven Manufacturing Company, New Haven, Conn., is now chief draftsman with F. P. Pfleghar & Son, of the same place.

L. F. Beers has taken charge of the Detroit office of the Buffalo Forge Company, succeeding H. M. Brightman, who is now connected with the Terry Bending Engineering and Construction Company, of Grand Rapids, Mich.

Corneil Ridderhof has disposed of his interest in the Wilmarth & Morman Company, of Grand Rapids, Mich., of which he is now treasurer and general manager, and expects to retire at the end of the present year. Mr. Ridderhof writes that he has formed no definite plans for the future, but is inclined to go West rather than East in forming a new connection.

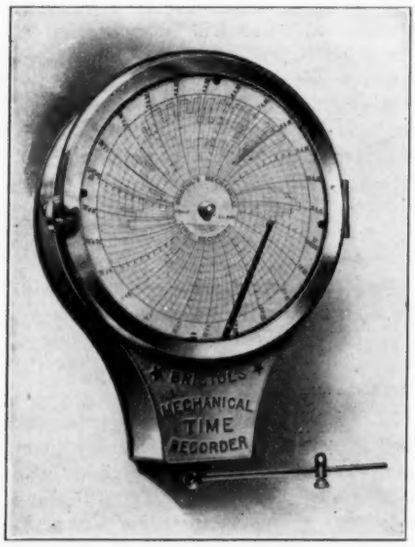
Obituary

Friederich Schreiner, widely known in manufacturing circles as the first man to make a success of the cold stereotyping process, and an inventor of note, died Oct. 22, at his home in Plainfield, N. J. He was born in Germany fifty-four years ago. He recently built a plant in this city for the manufacture of his numerous patents. His latest invention was a stereotype pressing machine.

NEW TOOLS AND MACHINE SHOP APPLIANCES

A MECHANICAL TIME RECORDER

The instrument shown in the illustration is intended for recording motions and rates of motion of such a variety that it is impossible to state its application to even a single industry, but as examples may be given a few of the devices whose movements it records. It can be used to record the rate of motion and position of sluice gates, turbine or engine governors, gate valves, the rise and fall of liquids in tanks, rivers, reservoirs, forebays, etc. In the gas industry it can be used to check up the operators and thus prevent the "blowing" of the holders at any time. A circular chart is rotated by clockwork at a uniform speed, while the pen moves



A MECHANICAL TIME RECORDER

over the chart an amount proportional to the motion to be recorded.

The pen arm is rigidly attached at its lower end to a shaft which is turned by a short arm projecting through a slot in the bottom of the case. The lever shown in the illustration projecting to the right is clamped to the short arm by a thumb nut. This lever is adjustable and can be clamped to the arm at any convenient angle. The motion to be recorded, after being reduced, if necessary, is imparted to the lever, which in turn transmits it to the pen.

The total scale on the chart is usually taken proportional to the total motion to be recorded. Reduced motion, if necessary, can easily be arranged by the aid of pulleys, levers or other reducing devices. Fine adjustments can readily be made by applying the motion at the proper point along the lever, and to facilitate this an attaching piece is provided, which is adjustable on the lever arm and secured in position by a thumb nut. It will be seen that by the aid of the adjustable lever arm and the adjustable slide on the arm, the instrument is adapted to record motions of all amounts and directions. Total deflection of the pen is obtained by turning the lever through an angle of about 21 degrees or 5 inches motion at its outer end. The chart is 8 inches in diameter.

Clock movements can be supplied for complete revolution of chart once in 15 minutes, 1 hour, 2 hours, 3 hours, 4 hours, 6 hours, 8 hours, 10 hours, 12 hours, 24 hours and 7 days.

Thus a speed may be selected to give best results under all the requirements. This recorder is made by the Bristol Company, Waterbury, Conn.

A COMBINATION WET AND DRY GRINDER

The half-tone and line cuts, Figs. 1 and 2, show a grinding machine designed for small shops or for shops where they wish to do a variety of grinding and are cramped for room.

The bearings are phosphor bronze and have removable sleeves. They are equipped with ring oilers. When they become worn, new sleeves are easily inserted. Ring check nuts and dust collars at the end of each bearing take up all end play and protect the bearings from dirt and dust.

The dry-grinding end is intended for grinding small pieces, castings or any rough work and is arranged, if desired, with a small surfacing table over the wheel for doing small surface work. The tool-grinder end of the machine is arranged for grinding tools using water on the tool to prevent drawing the temper. On the inside of the base there is cast as part of the base a large water tank which is air tight. Connecting with this tank is a pump which forces air on top of the water, forcing the water up through a pipe and into the upper tank under the wheel. As much or as little water may be obtained on the wheel as desired. Opening the air cock in the front of the machine allows the water to run from the upper tank under the wheel into the main tank

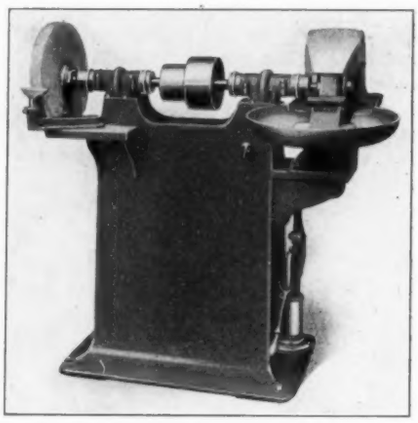


FIG. 1. A COMBINATION WET AND DRY GRINDER

inside the base. What sediment comes from grinding settles to the bottom of the upper tank as the outlet into the lower tank is some distance from the bottom of the upper tank. The sediment that collects can be easily taken out when a new wheel is put in. As the pipe on the tank inside the base does not run down to the bottom, comparatively clear water runs back into this tank so that it does not have to be cleaned oftener than once in about five years.

To fill the tank when installing the machine it is only necessary to open the air cock and pour water into the bowl of the tool grinder until it begins to run out of the air cock. This will give a supply of water that will last a long time.

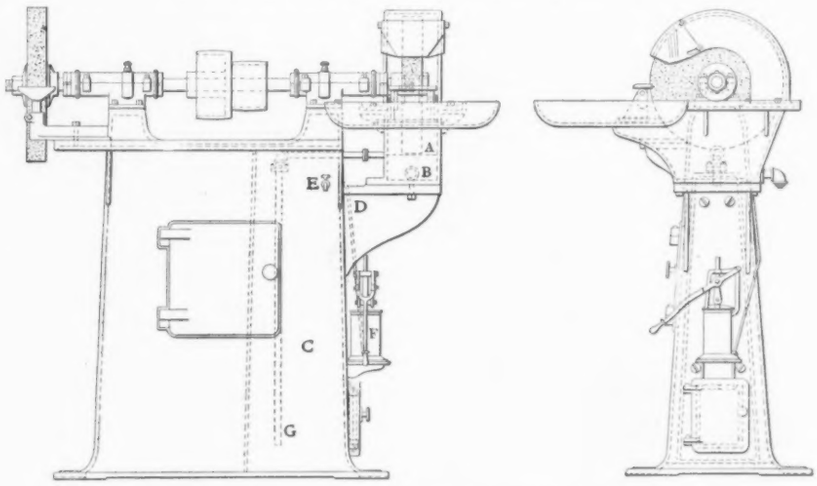
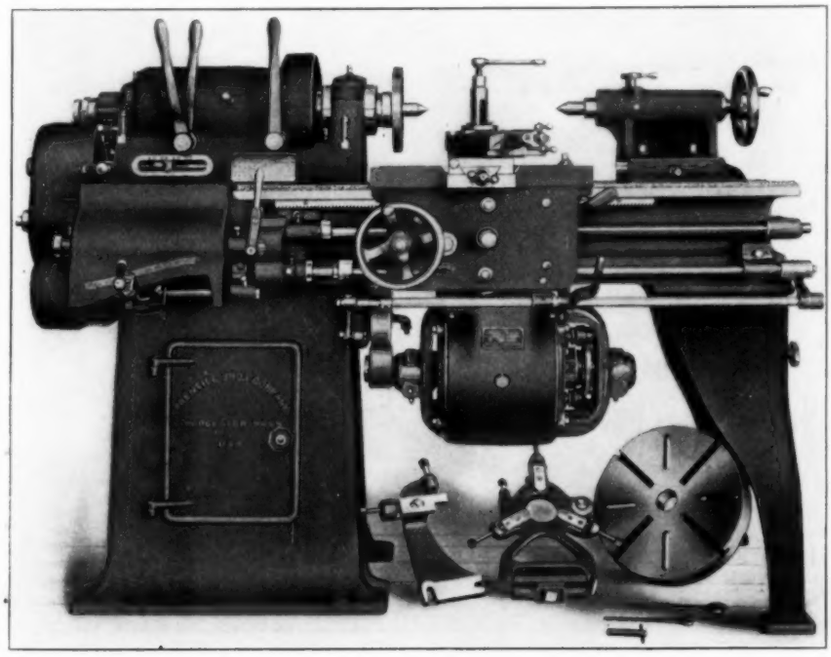


FIG. 2. CONSTRUCTION OF THE COMBINATION GRINDER

This machine is made by the Bridgeport Safety Emery Wheel Company, Inc., Bridgeport, Conn.

FOURTEEN-INCH PORTABLE LATHE WITH GEARED HEAD AND MOTOR DRIVE

This lathe is especially adapted for use around the machine shop for doing repair work or for use in the setting-up room. A number of these machines are being built by Prentice Brothers Company, Worcester, Mass., for the New York, New Haven & Hartford Railroad Company's shops at Readville, Mass. These will be used for repair work, where it is of advantage to be able to move the lathe to the particular locomotive that is being overhauled. The motor being attached directly to the lathe as shown, the tool can be readily moved from one position to another by means of hoists or traveling cranes and it is then only necessary to connect the wires from the motor to any convenient socket. In construction this lathe is practically the same as the regular 14-inch geared-head tool of the same builders. The head provides in itself for eight changes of speed for the spindle, which are secured by means of friction clutches manipulated by the levers at the front, the changes being made without stopping the spindle. The quick-change feed gear mechanism provides for 44 changes, giving a screw-cutting range from 2 to 60 threads per inch, and a range for turning from 0.002 to 0.033 inch per turn of spindle. The

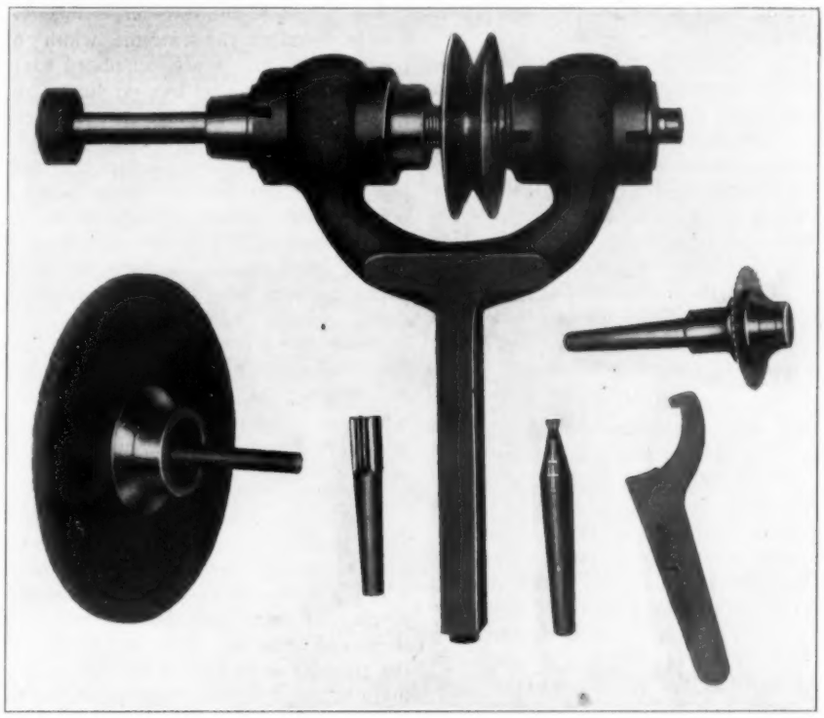


14-INCH PORTABLE LATHE WITH GEARED HEAD AND MOTOR DRIVE

lead screw is used only in screw cutting. Automatic stops are provided for disengaging the feed-rod clutch. The spindle has a front bearing 2½ inches diameter x 5 inches long, and the swing over the ways is 15¼ inches, the swing over the compound rest being 10 inches.

TOOL-POST GRINDER FOR BENCH LATHE

The frame of this attachment is a steel casting and is secured in the slide-rest tool post the same as an ordinary turning tool.



TOOL-POST GRINDER FOR BENCH LATHE

The spindle is of tool steel, hardened and ground, with straight bearings running in bronze boxes. The boxes are split, tapered on the outside and mounted in steel bushes, with a nut on each end, by which adjustment can be made to compensate for wear. They are protected at every point by dust caps and felt packing rings against the entrance of dust. The spindle has a taper hole to receive small disks on taper stems for internal grinding, and on the externally tapered nose of the spindle a wheel-mount may be attached to receive wheels for external grinding. The spindle is driven by a grooved pulley, taking a round belt about ⅛ inch diameter. Oil for the bearings is introduced at the end of the shank, which is hollow and serves as a reservoir. Small cutters and drills with taper stems may be furnished for this tool, thus adapting it for light milling and drilling. The grinder is made by the Pratt & Whitney Company, Hartford, Conn., for use with its No. 3 bench lathe.

A NEW UNIVERSAL ADJUSTABLE REAMER

A new adjustable reamer, which may be run to the bottom of a non-penetrating hole, is made with a cylindrical body having radial slots, decreasing in depth from front to rear. The blades which are inserted into these slots are correspondingly inclined on the lower edges. The body is threaded at both ends; at the rear, screwed upon a male thread, is a collar, which is exposed on the outside of the reamer; at the front, recessed so as to be entirely within the cutting edges of the blades, is the front collar, engaging a female thread in the body of the reamer. The collars engage the tapered ends of the blades by concave inner faces. The blades extend slightly in front of the front collar and body, so that they can go to the bottom of a hole, and there is no interference with the working out of the chips. The blades

are held rigidly their entire length; they are made of high-grade steel, high-speed steel if desired, while the body of the reamer is made of 30 carbon steel; they vary in number from 6 to 10, according to the diameter of the reamer. The shank is hardened.

It is claimed for this reamer that exact adjustment is readily attained. The adjustment is effected by changing the positions of the collars so as to move the blades longitudinally over the inclined bearing surfaces, the diameter being thus increased or diminished as desired.

This tool is made by the F. B. McCrosky Manufacturing Company, Meadville, Penn., the shell reamer being made in sizes from 1 9/16 inches to 10 inches, the machine and hand reamers being from 1¼ inches to 2½ inches.

A DRILL SPEEDER

This device has somewhat the appearance of a tapping chuck and is intended for use on large drill presses when small drills are being used. The upper end of the device has a taper shank which fits the spindle of the drill press. The case is kept from turning by a rod passing from it to the column or other stationary object. Gearing in the case increases the spindle speed 4 to 1. A sensitive lever actuates the spindle of the drill speeder.

This device is made by the Graham Manufacturing Company, Providence, R. I.

A ROLLING PIPE CUTTER

This machine is for cutting pipe and tubing. The cutter shaft is driven direct from the driving shaft by gearing.

A tight and loose pulley are mounted on the driving shaft. The cutter is of tool steel. It is raised and lowered by means of a screw.

The rollers, which support the pipe immediately under the cutter disk, are of large diameter and run on hardened steel pins. The machine is supplied with an oil tank and pan, so that oil may be used if desired. These pipe cutters are made in two sizes, with capacities from ¼ to 2 inches and 1 to 4 inches, respectively. The makers are Bignall & Keeler Manufacturing Company, Edwardsville, Ill.

A NEW BLUE-PRINT MACHINE

A new and interesting continuous blueprinting machine has been brought out by the Revolute Machine Company, of 523 West Forty-fifth street, New York.

It consists of a comparatively small, continuously revolving glass cylinder within which are placed two high actinic power mercury vapor electric lamps. The cylinder lies in a series of narrow belts which serve to maintain contact between the tracings and the cylinder. The roll of prepared paper is placed in a box on top of the machine and feeds in continuously between the belts and the cylinder or, if but few prints are wanted, separate sheets are used. The tracings are inserted between the paper and the cylinder and after passing three-quarters around the cylinder are deposited with the exposed paper below and in front of the machine.

The length of the cylinder is five feet which measures the extreme width of tracing which can be accommodated while the length, obviously, has no limit. In cases where several prints are required from the same tracing the leading edge of the tracing is re-inserted before the trailing edge comes out, the result being a continuous stream of duplicate prints. In a recent case twelve prints from a six-foot tracing were made on one sheet of paper 72 feet long with no waste of paper and no loss of time. The machine is driven by a motor, the speed of which may be quickly changed to adjust the tone of the prints which, at a given speed and with a given quality of paper, must obviously be uniform.

The Vindex Electric Company, of Aurora, Illinois, are making a transformer for electric-lighting circuits, by means of which a low voltage is secured for the ringing of bells and similar service in shops and factories. This does away with the troubles arising from the use of primary batteries for that purpose, and eliminates much of the difficulty experienced with bell circuits.

Business Items

The Tudor Manufacturing Company, of Worcester, Mass., a Massachusetts corporation, has been organized with a capital stock of $500,000, $250,000 preferred and $250,000 common. It has purchased the assets, patents and good will of the Bay State Tool Company, of the same city, and will continue to manufacture the line of Bay State quick-acting monkey wrenches, ratchet wrenches, quick-acting clamps and other tools. This new company was organized for the purpose of obtaining capital to enlarge the plant to meet the increased demand for these tools.

Manufacturers

The Cook Cooler Company, Flint, Mich., will erect a new factory.

The James A. Spargo Wire Company, Rome, N. Y., will erect a new plant.

The city of Milwaukee, Wis., has bought a site for a municipal light plant.

Sharp Brothers, Milwaukee, Wis., boilermakers, will erect a new plant.

The Empire Foundry Company, Syracuse, N. Y., will erect a new factory.

The Santa Fe Railway Company will erect a new roundhouse in San Angelo, Tex.

The Bennington Typewriter Company, Columbus, Ohio, will erect a new factory.

The Keystone Cement Block Company, Allentown, Penn., will erect a new plant.

The Montreal (Que.) Rolling Mills will erect a $25,000 factory in St. John, N. B.

The Palestine (Texas) Electric Light Company has purchased site for its new plant

The Albion (Mich.) Malleable Iron Company will erect two new foundry buildings.

The Martin-Culbertson Company, of Des Moines, Iowa, will build a new planing mill.

The Consolidated Press and Tool Company, Chicago, Ill., will move to Hastings, Mich.

The Simplex Electrical Company, Cambridge, Mass., will erect an addition to its plant.

The Massachusetts Mohair Plush Company, Lowell, Mass., will erect a new $20,000 dye house.

A $50,000 addition is being built to the plant of the Havana (Ill.) Metal Wheel Works.

The Waterloo (Iowa) Cement Machinery Manufacturing Company plans to build a new factory.

Rennous, Kleinle & Company, Baltimore, Md., will erect an addition to their brush factory.

The Cook Spring Company, New York, is having plans prepared for a $50,000 factory in Jersey City.

A forge shop is to be built at the plant of the Reed & Prince Manufacturing Company, Worcester, Mass.

The Star Corundum Wheel Company, Detroit, Mich., will erect a new plant and triple its output.

The Dominion Pipe Company, New Westminster, B. C., has secured a site for its proposed factory.

The Red Jacket Manufacturing Company will double the size of its foundry at West Davenport, Iowa.

The Empire Iron and Metal Company, of Brooklyn, N. Y., is having a plant erected in Perth Amboy, N. J.

The Hoquiam (Wash.) Lumber and Shingle Company will spend a half million dollars in improving its plant.

Catalogs

The John M. Rogers Works, Gloucester City, N. J. Catalog of adjustable reamers. Illustrated, 6x9 inches, 24 pages, paper.

Butterfield & Co., Derby Line, Vt. Catalog of taps, stocks and dies, reamers, etc. Illustrated, 6x9 inches, 84 pages, paper.

Case Manufacturing Co., Columbus, Ohio. Bulletin No. 22, describing electric cranes. Illustrated, 9x12 inches, 30 pages, paper.

A. D. Granger Co., 9 Liberty St., New York. Bulletin No. 2, describing Star safety water-tube boilers. Illustrated, 6x9 inches, 27 pages, paper.

Crocker-Wheeler Company, Ampere, N. J. Bulletin No. 69, describing small generators arranged for direct connection. Illustrated, 7x10 inches, 4 pages, paper.

The Tabor Manufacturing Company, 18th and Hamilton streets, Philadelphia, Penn. Catalog of Tabor hinged molding machine. Illustrated, 6x9 inches, paper.

F. B. McCrosky Manufacturing Co., Meadville, Penn. Catalog and price list of the new patent adjustable reamers. Illustrated, 3½x6 inches, 15 pages, paper

The Gleason Works, Rochester, N. Y. Catalog of gear planers. This is a handsome book with excellent half-tone illustrations mounted on heavy ribbed paper. 10x12 inches.

The Jeffrey Manufacturing Co., Columbus, O. Chain catalog No. 80, which illustrates elevating, conveying, power-transmitting machinery and chains. 6x9 inches, 376 pages, cloth.

Wisconsin Engine Co., Corliss, Wis. Supplementary catalog E-3, showing in a general way the distinctive features of the Corliss engine built by this company. Illustrated, 7x10 inches, 57 pages, paper.

The Dayton Pneumatic Tool Co., Dayton, O. Circular illustrating and describing Green Pneumatic hammers.

The Waterbury Farrel Foundry and Machine Co., Waterbury, Conn. Catalog, Section A, descriptive of rivet, bolt, nut and screw machinery. Illustrated, 6x9 inches, 77 pages, paper.

General Electric Co., Schenectady, N. Y. Sept. 1, 1906, catalog of railway supplies. This is a very comprehensive book, containing 233 pages, and bound in cloth. Illustrated, 8x11 inches.

Miscellaneous Wants

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad St., New York.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machry. to order; models and elec work specialty. E. O. Chase, Newark, N. J.

Dies and Diemaking, $1.00. A shop book by a shop man. J. L. Lucas, Bridgeport, Ct.

Novelty in tool or machine specialty wanted. Particulars required. Box 202, AMER. MACH.

Special machinery designed and built. Walter S. McKinney, M. E., 43 Broadway, Flushing, N. Y.

Tools, dies and special machinery built by contract. Chas. ..abb Co., 635 Kent avenue, Brooklyn, N. Y.

Gas engines designed to order. Marine and automobile work a specialty. H. L. Towle, 150 Nassau street, New York.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Universal grinding machine, about 12x32, new or second-hand, first-class condition, wanted; immediate delivery. Box 237, AMERICAN MACHINIST.

Wish to place contract for yearly supply of gray-iron castings, similar to gas-engine castings; about four tons daily. R. X. Y., Box 283, AMERICAN MACHINIST.

Wanted—Second-hand power bending machine. Also combination punch and shears to cut up to ¾-inch stock Genesee Valley Mfg. Co., Mount Morris, N. Y.

Special high-grade machinery built to order. Automatic and otherwise electrical work a specialty. Complete modern equipment. Automatic Machine Development Company, 130 East 12th street, New York.

Engineers' Handbook of Standard Dimensions of Details and Machinery, 250 blueprinted tables, leather bound, sent prepaid on receipt of price, $3.50. M. Neumayer, M. E., First National Bank Building, Cincinnati, O.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Wanted — Address of F. A. Oakley, employed in 1899 with Pratt & Whitney, of Hartford, Conn., as foreman of model department. Address James H. Dean, care Dean Ballot Machine Company, Minneapolis, Minn.

Be an expert steel worker by using Toy's Treatise on all new steels and welding the different kinds of steel solid; also two colored tool-tempering charts, hardening and tempering all tools to a standard—all for one dollar. Valuable samples free W. M. Toy, Sidney, O.

Wanted—By one of the largest and most important firms of crucible steel manufacturers in Sheffield, England, a representative for the United States. Only firms in a position to give first-class references need apply. Address "A. B.," care T. B. Browne's Advertising Offices, 163 Queen Victoria St., London, E. C., England.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

Business Opportunities

Wholesale hardware company wants business man for manager; must buy substantial interest; nets $30,000 annually. Box 309, AMERICAN MACHINIST.

Large, old re-enforced concrete company wants good business man; need not know line; must invest; dividend paying. Box 310, AMERICAN MACHINIST.

Wanted to contract with shop within 50 miles of New York City, equipped for making highest-grade automobile chassis. Must have capacity for at least 100 cars per year and able to do highest grade interchangeable work cheaply. No body work. Box 210, AM. MACH.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the constructon of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Gas engine, almost new, 8 to 10 h.p.; $150. G. R. Lang Co., Meadville, Pa.

For Sale—One Binsse No. 1 B horizontal boring machine with 36-inch table; brand-new, never used; will trade for No. 4 plain Cincinnati milling machine, if in good order. Continental Motor Mfg. Co., Muskegon, Mich.

Wants

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Position as superintendent; practical, systematic and fully reliable, with wide knowledge in machine and foundry practice; permanent position desired; will consider nothing less than $3000 the first year; correspondence strictly confidential. Box 311, AM. M.

MASSACHUSETTS

Position wanted by factory manager; technical engineer; thorough knowledge of modern mechanics; specialist in foundry and machine-shop production; diplomacy and tact in handling of labor highly endorsed; record clean and will stand fullest investigation; age 35; compensation to be arranged; can report on 30 days' notice. Address "American," Box 273, AMERICAN MACHINIST.

NEW JERSEY

Mechanical engineer, college graduate, wide experience in shop and office solely in gas producers of the suction and pressure type and producer-gas engines, designing, gas analysis, testing; can introduce new type of good paying suction producer and wishes to connect with enterprising manufacturer for responsible situation; holds at present position as general designer with first-class concern. Box 305, AMERICAN MACHINIST.

NEW YORK

Mechanical engineer, competent, experienced man, with some capital, seeks business opportunity. Box 302, AMERICAN MACHINIST.

Wanted—Position as superintendent or general foreman by experienced party; specialty, automobiles and machinery. Box 315, AM. M.

Foreman or superintendent; successful in producing first-class work at satisfactory cost in gas and kerosene engine; desire change. Box 312, AMERICAN MACHINIST.

Practical mechanical draftsman, technical graduate, 26, over eight years' experience, four years' shop exeprience, A-1 references. W. D., 255 West 22d St., New York.

Inventor, with 10 years' experience in steam engines, automatic machinery, die work and steam turbines is open for a first-closs engagement. Box 252, AMERICAN MACHINIST.

Machine shop and foundry superintendent, with good business experience, desires change; executive, progressive, successful; present position outgrown. Address Box 288, AM. M.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted — Experienced draftsmen on jigs, fixtures and tools; give age, experience and wages expected. Ross Rifle Co., Quebec, Canada.

Wanted—Toolmakers experienced on fixtures, dies and gages. Applicants should give age, experience and wages expected. Ross Rifle Co., Quebec, Canada.

Wanted — An experienced tool designer; small interchangeable parts made in large lots; range of tools—punches and dies, jigs, milling fixtures, screw-machine fixtures and cams; a good opening for the right man. The Northern Electric and Mfg. Co., Ltd., Montreal, Quebec.

CONNECTICUT

Wanted—First-class operator on Jones & Lamson turret lathe; also one first-class all-around machinist. The New Machine Co., Danbury, Conn.

Wanted — Tool makers, die sinkers, drop forgers and men familiar with grinding machines. Apply to D. P. Beckwith, Pope Manufacturing Company, Hartford, Conn.

ILLINOIS

Wanted—By large wagon factory, experienced mechanical draftsman for work on traction trucks and heavy wagons. Box 238, AMERICAN MACHINIST.

Wanted—First-class mechanical draftsman with inventive ability to design bottle-labeling and other bottling machinery; state experience, reference and qualifications; good position for able man. Box 304, AM. MACHINIST.

Wanted—Technical man to take charge of our tempering department; one experienced in tempering all kinds of tool steel preferred; tempering room is one of the finest equipped in central West. H. Mueller Mfg. Co., Decatur, Ill.

INDIANA

Wanted—To buy a pair of heavy alligator shears, second-hand; if you have anything to offer, please quote price, state weight of the shears and capacity. South Bend Chilled Plow Co., South Bend, Ind.

MASSACHUSETTS

Wanted— Draftsman with experience in tool designing. Address, stating age, experience and salary expected, Lock Drawer No. 26, Boston, Mass.

Mechanical draftsmen wanted for general machine work, also structural steel work; state age, experience and salary expected. Box 251, AMERICAN MACHINIST.

Superintendent—Manufacturing plant, 500 hands, wants a man of experience to take charge of manufacturing; first-class man, with good reference. Box 307, AMER. MACH.

Wanted — Printing-press machinists, floor and vise hands especially; state experience, wages wanted, and how soon you could report. Huber-Hodgman Printing Press Co., Taunton, Mass.

Mechanical draftsman wanted on medium-weight special automatic machinery; shop located in eastern Massachusetts; please send age, experience and references; steady work and good pay. Box 298, AMER. MACHINIST.

Wanted—Two first-class machinists and one screw-machine operator; must understand Gisholt lathe; steady positions to competent men; state age and wages expected; factory near Boston. Box 270, AMERICAN MACHINIST.

An assistant superintendent for an iron foundry and machine shop employing about 350 men; must have good executive ability and be familiar with methods that produce results; state age, references, synopsis of experience and salary expected. Box 314, AMERICAN MACHINIST.

NEW JERSEY

Toolmaker wanted — First-class man for heavy jig and tool work; one to take charge of small tool room; state wages. Box 303, AMERICAN MACHINIST.

Draftsman, experienced on structural iron work, by manufacturers of electrical cranes near New York; state experience and salary wanted. Box 257, AMERICAN MACHINIST.

Wanted—Working foreman for small shop doing jobbing, mold work and building special machinery; give references and salary expected. Address "M," Box 201, AMER. MACH.

Several first-class tool and diemakers accustomed to high-grade work; steady employment and good wages to competent men. Sloan & Chace Mfg. Co., Sixth avenue and Thirteenth street, Newark, N. J.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

NEW YORK

Wanted—Experienced men on general tool work. Box 299, AMERICAN MACHINIST.

Wanted—Draftsman with some experience on jigs; salary, $16 per week. Box 313, AMERICAN MACHINIST.

Draftsman, mechanical; some knowledge of electric automobile construction desirable. Box 306, AMERICAN MACHINIST.

Wanted — Experienced draftsmen, toolmakers and machinists; give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

At our new factory—Toolmakers experienced in fine and complicated work; steady employment and good wages. Jones Speedometer Co., New Rochelle, N. Y.

Wanted, immediately—A draftsman; applicants must state salary expected and when they can commence work. Address A. A. P. C. W., Alsen, Greene Co., New York.

Draftsmen on jigs and fixtures for duplicating work; none but experienced men wanted; good pay for right men. Mergenthaler Linotype Co., 29-42 Ryerson St., Brooklyn, N. Y.

Wanted—Mechanical and electrical draftsmen. Apply, giving age, experience and salary expected. Engineer in Charge, Drafting Department. General Electric Co., Schenectady, N. Y.

Man wanted to represent us on the road; one acquainted with babbitt, solder and type-metal trade and preferably employed at present. This is a good opportunity for the right party. Box 266, AMERICAN MACHINIST.

Machinist foreman—A man 30 to 40 years old, first-class general machinist, fair electrician; familiar with gas or gasolene engines; good executive ability; willing to take charge of a night gang in iron works; steady position, long hours and good pay. Address, giving experience, references and wages expected, "Machinist," P. O. Box 672, New York.

OHIO

Machine-tool draftsmen wanted for Ohio; detailers or designers. Box 245, AM. MACH.

Wanted—Designers and detailers on heavy machine tool work; state age and experience. Box 218, AMERICAN MACHINIST.

A man competent to take charge of tap and die department may learn something interesting by addressing Box 308, AMER. MACH.

Several first-class draftsmen, thoroughly familiar with steam-hammer designing; state experience, age and salary expected. Box 301, AMERICAN MACHINIST.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

The National Metal Trades Association can place a few first-class toolmakers, patternmakers and blacksmiths. Positions will be guaranteed as steady and at highest prevailing rate of wages. This is an opportunity for first-class men to secure one of the N. M. T. A. certificates of recommendation. For further particulars address The National Metal Trades Association, Cincinnati, O.

Wanted — Superintendent of a large and growing factory, employing now about five hundred (500) hands, manufacturing high-class electrical product, wishes an assistant thoroughly up-to-date on quick interchangeable work at lowest cost; a man to become master mechanic in time; this is an excellent opportunity. Reply, giving age, whether married or single, past experience in detail. All letters acknowledged and held confidential. Box 205, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—Ten machinists, general machine and bench hands; also two A-1 patternmakers. Apply to Scottdale Foundry and Machine Co., Scottdale, Pa.

Machinists wanted—Leading men that work from drawings on floor and assembling crane work. Alfred Box & Co., Front and Poplar streets, Philadelphia, Pa.

Wanted—Experienced operator for Jones & Lamson lathe; steady work in a good town. Write Wilson Laundry Machinery Company, Columbia, Lancaster County, Pennsylvania.

Machinist experienced in running double-stroke headers; good wages and permanent position to first-class man. Metallic Specialty Mfg. Co., 1616-1628 North 21st St., Philadelphia, Pa.

Wanted—Lathe foreman capable of producing good work at minimum cost for growing shop now employing forty (40) hands; good opportunity for the right man. Wilson Laundry Machinery Company, Columbia, Lancaster County, Pennsylvania.

Machine-shop foreman wanted, preferably young man with technical education; must be thoroughly able to get the maximum amount of work from the machines under his control; state experience, qualifications, salary expected, and references. P. O. Box 3047, Fairhill station, Philadelphia.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections, these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND

Wanted—First-class milling-machine man to take charge of 12 machines. Box 300, AM. M.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN

To cope with the continuous enlargement of our business, first-class machinists, patternmakers, molders and boilermakers can find steady employment. Box 899, Milwaukee, Wis.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

WEST OF MISSISSIPPI

The J. Geo. Leyner Eng. Wks. Co., of Littleton, Colo., are increasing their plant and are in need of good mechanics, machinists, blacksmiths and sheet-iron workers. Littleton is a suburb of Denver, where cost of living is reasonable; superb climate the year round. Address above.

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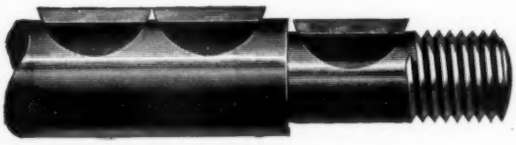

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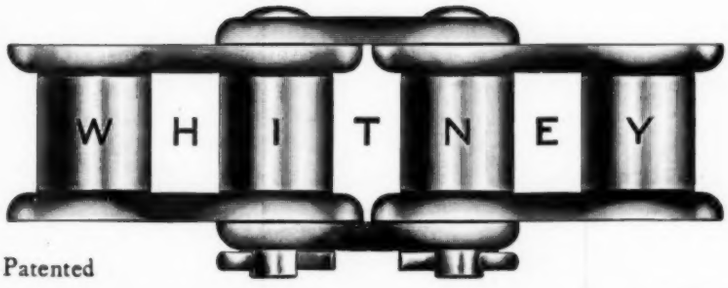

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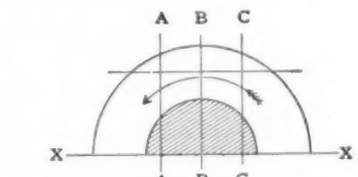
WORM CONTACT—I*

Some Interesting and Somewhat Neglected Aspects

BY ROBERT A. BRUCE

Though the subject of worm-gearing has been less thoroughly explored than that of spur-gearing, it might nevertheless be anticipated that little remains to be said on either from a purely theoretical point of view. Experimental investigation of the actions involved in worm-gearing has been singularly incomplete, but many writers have contributed to the theory of the subject. In spite of what has been written, some of the most interesting aspects of the question have been overlooked or ignored, with the result that there is no single source from which a complete account of the action of worm-gearing can be gathered. The present paper is intended rather to cover some of the more obvious omissions than to give a complete account of this form of gearing. A complete explanation would be impossible within the compass of a paper of reasonable length.

The comparative completeness of the theory of spur-gearing is due to the fact that the whole action of such gears may be studied in a single plane perpendicular to the axes about which motion takes place. The successive positions of the tooth-profiles in this plane, though not capable of continuous representation on a plane diagram, may be drawn at close intervals, and a tolerably clear conception of the motion may be gathered by the aid of a corresponding series of figures.



Double-Threaded R.H. Worm, 4″ pitch, 4″ outside diam., 3″ pitch diam.
FIG. 1. Transverse Section.

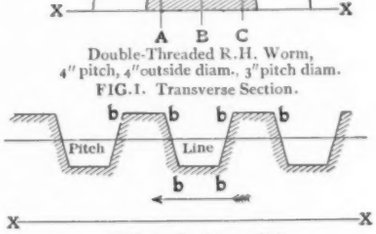


FIG. 2. Section on B-B.
(As seen from left of B-B in Fig. 1)

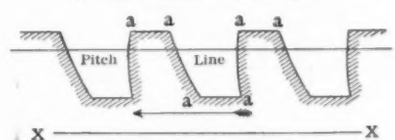


FIG. 3. Section on A-A.
(As seen from left of A-A in Fig. 1)

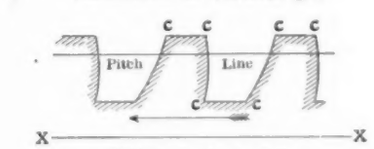


FIG. 4. Section on C-C.
(As seen from left of C-C in Fig. 1)
("Obverse" of a-a-a in Fig. 3)

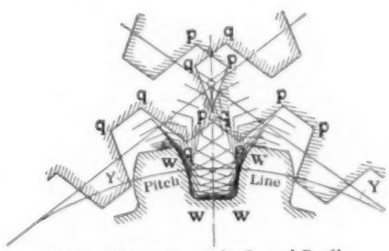


FIG. 5. Generation of the Central Profile of Worm-Wheel Teeth.

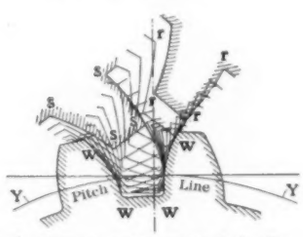


FIG. 6. Generation of Worm Teeth Profiles in Plane A-A (Fig. 3).

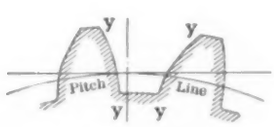


FIG. 7. Section of Worm-Wheel in Plane C-C (Fig. 4).
("Obverse" of w-w-w in Fig. 6).

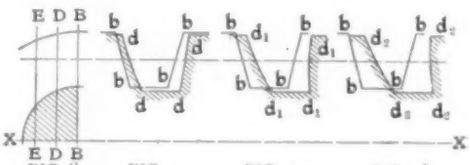


FIG. 8. Transverse Section.
FIG. 9. Section of Worm.
FIG. 9a. Pitch doubled.
FIG. 9b. Pitch trebled.
Diagrams showing increased Distortion with increased Pitch. Three Sections on D-D (Fig. 8).

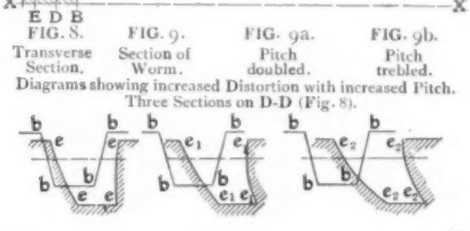


FIG. 10. Section of Worm.
FIG. 10a. Pitch doubled.
FIG. 10b. Pitch trebled.
Three Sections on E-E (Fig. 8).
Diagrams showing further Distortion as Plane of Section is removed from Central Plane.

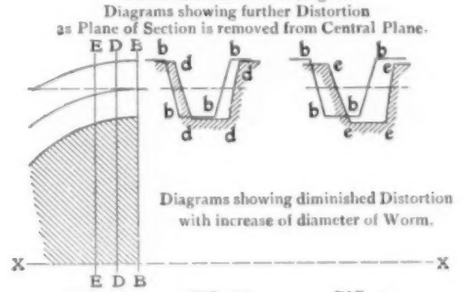


FIG. 11. Transverse Section.
FIG. 12. Compare Fig. 9b. Same Pitch. Diameter doubled.
FIG. 13. Compare Fig. 10b. Same Pitch. Diameter doubled.

Thus Fig. 1 represents a transverse section of a double-threaded RH worm, 4 inches outside diameter, 3 inches pitch diameter, 4 inches pitch. The section on a plane through the axis is shown in Fig. 2, the observer being situated on the left of *B B* in Fig. 1. The profile remains unchanged in shape as the worm rotates, but is translated from right to left as shown by the arrow. Figs. 3 and 4 are respectively sections by planes *A A* and *C C*, the observer being situated in each case to the left of *A A* and *C C* in Fig. 1. As the worm rotates the same constancy of form, combined with a definite rate of translation, is seen to occur. In order to study the action of a worm-gearing with a worm-wheel, it is only necessary to choose *B B* so that it is the plane through the center of the worm-wheel. *A A*, *B B*, and *C C* will then be definite planes in the worm-wheel perpendicular to the axis about which it rotates. The tooth-profiles of the worm-wheel in any particular plane, such as *B B*, must be such that they would correctly gear with a rack of the form *b b b*, in Fig. 2. Similarly the tooth-profiles of any plane section *A A* must be such as to gear correctly with a rack *a a a a*, Fig. 3. The plane whose trace is *X X* must also remain at a constant distance from the axis of rotation. According to this view any section of a worm-wheel by a plane perpendicular to its axis is the conjugate of a rack whose profile is the section of the mating worm in the same plane. In other words, the profiles of the worm-wheel teeth are the envelopes of all the possible successive positions of the worm teeth which the latter can assume when working in proper relation to the former.

WORM-GEAR PROFILES.

In Fig. 5, the statement just enunciated is illustrated, several successive positions of the central section—that is, the section in the plane *B B* of Fig. 1—of the worm plane section of a worm parallel to its axis, and the worm itself is rotated while the plane remains stationary, it is found that the profile of the section remains the same, but changes its position, advancing uniformly in a direction parallel to the axis through a distance equal to the pitch.

*A paper read before the British Institution of Mechanical Engineers.

are shown in proper relation to the worm-wheel.

The profile of the worm-wheel is seen to be the envelope of the various outlines of the section of the worm-thread. The outline of the worm-thread, in moving from the position *q q q q* to *p p p p*, sweeps out the profile *w w w w*, which represents a boundary within which it cannot enter, but every part of which it is forced at some time to touch. The central section of the worm yields a symmetrical profile *bbbb*, Fig. 2, and the conjugate section of the worm-wheel is also symmetrical, Fig. 5. All other sections of the worm by planes, such as *A A*, or *C C*, parallel to *B B*, yield unsymmetrical profiles, and the conjugate worm-wheel profiles are also unsymmetrical.

Thus in Fig. 6, *r r r r* represents a section of the worm-thread by the plane *A A*, Fig. 3, in one of its proper positions relatively to the worm-wheel whose pitch line is *Y Y*; *s s s s* also represents the same worm-thread in another possible position, and sufficient intermediate positions of the profile have been drawn to show the unsymmetrical profiles of the worm-wheel teeth, which, as stated before, are merely the envelopes of the successive positions assumed by the section *a a a a*, Fig. 3, of the worm-tooth.

Fig. 7 represents a section of the worm-wheel by the plane *C C* situated on the side of *B B* opposite to *A A*, and at the same distance from it. It should be noticed that the sections *a a a*, *c c c*, in Figs. 3 and 4, are sections of the worm-threads by planes symmetrically situated, with reference to the central plane *B B*, and that either may be regarded as the obverse of the other. That is to say, *c c c*, Fig. 4, presents the same appearance to an observer in front of the plane of the diagram as *a a a*, Fig. 3, presents to an observer situated at the back of the plane of the diagram. In the same way the section *y y y y*, Fig. 7, which is the conjugate or envelope of the successive positions of *c c c*, Fig. 4, is merely the obverse of the section *w w w*, Fig. 6, which is the conjugate of *a a a*, Fig. 3. Regarded in this way the whole surface of the worm-wheel is realizable, for it is clear that the positions of the planes *A A*, *B B*, in Fig. 1, have been selected in a perfectly general manner. It should be noticed that, as the plane of section is removed farther away from the central section, there is an increasing tendency of the worm-thread to become skewed or distorted, leading to a similar tendency on the part of the conjugate profile of the worm-wheel teeth. The effects of increasing the pitch, or decreasing the pitch diameter of the worm, are precisely similar, skewing or distortion being in each case increased. These statements will become clear on studying Figs. 8 to 9b.

Fig. 8 represents a quadrant of the transverse section of a worm. *B B* is the trace of a plane containing the axis, and *D D* and *E E* are the traces of planes parallel to *B B*.

In Fig. 9 the shaded profile *d d* represents the section of the worm by the plane *D D*, *b b* being the section by the central plane.

In Figs. 9a and 9b the effect of doubling and then trebling the pitch is clearly shown, the tendency to "skew" being very marked as the pitch is increased.

In Figs. 10, 10a and 10b, sections in the plane *E E* of Fig. 8 are exhibited in conjunction with the central section and the effects of departure from the central plane and increase of pitch are illustrated by the increasing tendency of the sections *e e* to become distorted.

Figs. 11, 12 and 13, are sections of a worm of double the pitch diameter of Fig. 8, the pitch and the form of thread remaining unchanged. Fig. 13 compares in all respects except pitch diameter with Fig. 9b, the pitch and distance of the plane of section from the central plane being identical. The effect of increasing the diameter is to very much regularize the profile of the sections in planes parallel to the central plane.

Fig. 13 may be compared with Fig. 10b and the effect of increasing the diameter is seen to be equally marked in the case of sections by the plane *E E*. These illustrations will serve to explain the general tendency of the forms assumed by correctly shaped worm-wheels. Valuable as it is that correct notions on these points should be current, they are not of immediate practical importance.

METHOD OF MAKING WHEELS.

Though accurate machine methods of producing worm-wheels have been known for at least 70 years (Sir J. Whitworth patented his hobbing machine in 1835), nearly all worm-wheels in common use till within late years were cast from wooden patterns. The production of the pattern was seldom dependent upon the previous accurate determination in the drawing office of the correct profiles of its various sections. The most expeditious method in vogue was to form an approximate pattern of the worm-wheel and mount this upon a vertical stud carried on the slide rest of a lathe so that its central plane was horizontal and level with the centers. The actual worm (or a duplicate of it cut in lead) with which the wheel cast from the pattern under construction was to gear, was mounted between the centers of the lathe, and the two were brought as nearly as possible into gear. The rotation of the worm which was covered with "marking," in the partially formed pattern, marked the "high points," which were then carefully removed by the pattern maker, and this process was continued till the bearing of the worm in the wheel was judged sufficiently good, and the correct center distance was reached. This process, tentative and tedious as it may appear, is performed at a less cost and leads to better results than the method of determining the correct sections of the teeth on various parallel planes, and shaping the teeth to the marked lines with the aid of intermediate templates. On the other hand, the various methods by which the worm-wheel teeth are cut do not require accurate predetermination of the form of the teeth. So that, however produced, a correct knowledge of the forms of the teeth is necessary rather for *comprehension* of the finished article than for its production.

TOOTH CONTACT.

A much more important question now presents itself. Given a perfectly formed worm-wheel and its mating worm, what is the nature and extent of the contact that takes place, and how are these affected by the proportions assumed? It is evident that a knowledge on these points must be gained before a really satisfactory basis for determining the proportions of worm-gearing for a given load or duty is arrived at, and until some satisfactory theory is developed purely empirical methods must be used.

In developing the theory which follows, the method of procedure is to examine what takes place in various planes parallel to the central plane of the worm-wheel. And, as has been already pointed out, the action of the sections of the worm and worm-wheel by such a plane is precisely analogous to gearing together a rack and wheel. When a rack tooth is in contact with an engaging wheel-tooth the common normal at the point of contact of the tooth-profiles must pass through the pitch point or point of contact of the pitch lines. This is the fundamental condition which must be obeyed by any profiles whatever which are suitable for correct gear teeth. This statement needs no formal proof, for at any moment the correct motion of the pitch surface of the wheel relatively to the rack or that of the rack relatively to the wheel is one of rotation about the pitch point as virtual center; any other disposition of the surfaces of the teeth in contact than that stated, would therefore lead either to their separation or interpenetration. Thus in Fig. 14 the pitch line of the rack is *pR*; that of the wheel being *pW*, which touches *pR* at the pitch point *p*; *rr* is one position of a rack or worm-tooth. The point at which contact takes place can now be readily determined, for, if a normal *pa* be drawn from *p* to *rr*, *a* is the only point which fulfils the condition laid down; *w w* the profile of the wheel-tooth, must also touch *rr* at *a*, and *pa* must be normal to it. On this condition alone is rotation about the instantaneous center *p* possible. As a rack tooth passes all its stages of contact with an engaging tooth, the position of the point of contact is continually changing, and relatively to the pitch lines its path is determinable and is termed the path of contact. The path of contact for any particular rack tooth can

be readily found as follows: $r_1 r_8$ is the profile of the driving side of a rack tooth, and $p_1 p_8$ is the pitch line, Fig. 15. Normals $p_1 r_1, p_2 r_2 \ldots p_8 r_8$, are drawn at intervals to cut the pitch line at $p_1, p_2 \ldots p_8$. When contact takes place at r_1, p_1 must coincide with the pitch point; similarly when contact is at r_2, p_2 coincides with the pitch point. If therefore, as in Fig. 15a, the normals and the profiles are re-drawn in the successive positions, when contact takes place at $r_1, r_2 \ldots r_8$, a series of points on the contact path will be obtained, and a fair curve through these gives the contact path $r_1 \ldots r_8$, Fig. 15a. The shape of the contact path depends solely upon the shape of the rack tooth. Thus in Fig. 15a a rack tooth convex with regard to the mating tooth has a curved contact path concave toward the center of the mating gear. If, however, a rack tooth is concave on the side of the mating tooth, the path of contact is curved so as to be convex toward the center of the mating gear, as in Figs. 16 and 16a, while a straight line rack tooth has a straight line path of contact. The curvature of the contact path is greater or less according as the curvature of the profile of the rack tooth is greater or less, and its inclination to the pitch line is also greater or less according as the inclination of the rack tooth profile is greater or less.

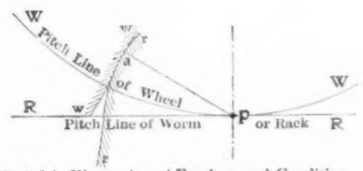


FIG. 14 Illustration of Fundamental Condition of Contact of Profiles.

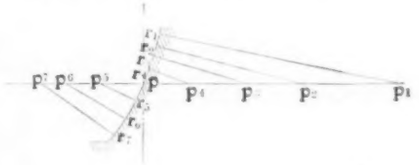


FIG. 16 Concave Profile.

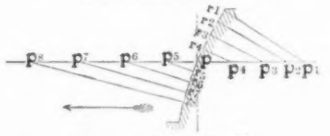


FIG. 15 Convex Profile.

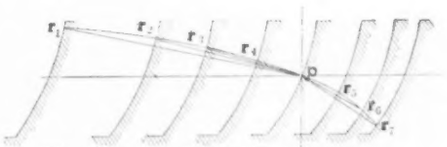


FIG. 16a Contact Path for Concave Profile.

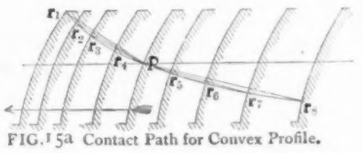


FIG. 15a Contact Path for Convex Profile.

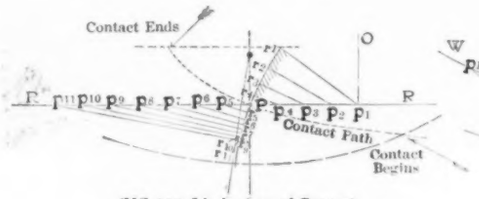


FIG. 17a Limitations of Contact

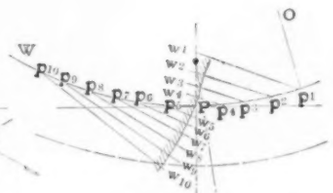


FIG. 17b Construction of Conjugate Profile

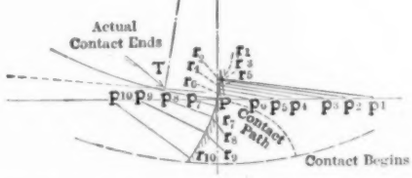


FIG. 18a Limitation of Contact due to Interference

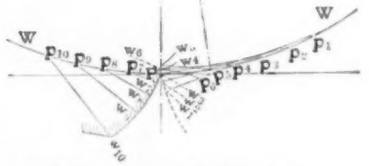


FIG. 18b Construction of Conjugate. (w_3–w_5) is "imaginary."

LIMITATIONS OF PATH OF CONTACT.

The limitations of the paths of contact are determined in general by its intersections with the paths of the extremities of the mating tooth-profiles. Contact commences at the intersection of the contact path with the circle limiting the worm-wheel teeth, and ends at its intersection with the straight line through the tips of the worm-teeth. In certain cases, however, the path of true contact is considerably abridged by reason of interference. In order that the path of contact may be determinable for any plane section selected, it is necessary to know when interference is likely to occur, and for this purpose it is necessary to study in greater detail the method of obtaining the conjugate of any given rack or worm profile.

In Fig. 14 the line ap, which is a normal of the rack tooth, is also a normal of the wheel-tooth at the point of contact, and the same holds for any other point of contact.

In Fig. 17a $r_1 p_1$, $r_2 p_2$, etc., are normals of the rack profile $r_1 r_{11}$, when r_1, r_2 etc., are points of contact, and p_1, p_2, etc., coincide with the pitch point P. Hence if WP is the pitch line of the wheel gearing with the rack whose profile is $r_1 r_{11}$, points w_1, w_2, etc., can be obtained on the conjugate profile which will come into contact with the points r_1, r_2, etc., of the rack profile as follows:

Make the arc $p_1 P$, Fig. 17b, equal to the line $p_1 P$, Fig. 17a, and draw $p_1 w_1$ equal to $p_1 r_1$ and inclined to the radius $p_1 O$ at an angle equal to $O p_1 r_1$ in Fig. 17a. Find p_2 and w_2, etc., in a similar manner.

It is obvious that if P in Figs. 17a and 17b were brought into coincidence and the pitch lines were brought into their proper relative positions so that p_1, p_2, etc., successively coincided at P, then w_1 would coincide with r_1, and $w_1 p_1$ with $r_1 p_1$; also in its turn w_2 would coincide with r_2, and $w_2 p_2$ with $r_2 p_2$, so that w_1 is one point, and w_2, w_3, etc., other points of the conjugate profile. This method of using the normals to construct the conjugate of the rack profile is therefore an alternative to the method of envelopes already described. It is evident in Fig. 17a that as the lower part of the convex profile is approached the normals greatly extend in length, and if they are drawn for portions below r_{11}, the direction of the normal will ultimately be parallel to the pitch line, and hence will never meet it. It will now be impossible to find any point on the conjugate profile which will come in contact with a point in the profile from which a normal parallel to the pitch lines is drawn. When, therefore, the path of contact becomes parallel to the pitch line of the rack, further contact becomes impossible.

A limitation in the other direction is illustrated in Figs. 18a and 18b. The rack profile is here concave and the path of contact is such that a circle concentric with the pitch circle touches it at T. Contact beyond this point T cannot take place. For if the construction already described be applied in Fig. 18b to find the conjugate profile, we find that the resulting curve has a cusp and that the second branch of the curve $w_5 w_1$ corresponding with that portion of the contact path beyond T, is of such a character that, though the mathematical relationships hold good, physical contact is impossible. If the case be carefully examined it will be seen that contact between the branch $w_5 w_1$ and the rack $r_1 r_8$ would take place on the opposite side of $r_1 r_8$ to that on which contact occurs between the portions $w_5 w_{10}$ and $r_8 r_{10}$. The actual contact path therefore is liable to limitations in two ways: (1) through interference, and (2) through the limitations of the mating teeth themselves. When contact ends through interference, the points at which contact vanishes are

those at which the contact path coincides in the direction with the motion of either of the moving members, that is, where the contact path becomes parallel to the straight pitch line or is touched by a circle concentric with the circular one. In the second case, as already stated, contact ceases at the points of intersection of the contact path and the paths of the extremities of the tooth surfaces.

By the method described above, the contact path for any section of a worm parallel to the middle plane can be found, and if an infinite number of such planes be taken a surface of contact will be obtained. The actual amount of the surface of the worm in contact at any moment is the curved line of intersection of its own surface and the surface of contact. The representation of the surface of contact on a plane can be accomplished by drawing a number of lines of contact by various parallel planes in juxtaposition.

It is quite evident that the simplified spelling is making headway among machinery men. "Tho" and even "thru" are now quite often encountered in the letters of contributors and advertisers. Full information regarding the new spelling may be obtained gratis by addressing the Simplified Spelling Board, 1 Madison avenue, New York.

The city of Milwaukee, Wisconsin, through its city engineer, Charles J. Poetsch, has engaged the firm of Robert W. Hunt & Co., of the Rookery, Chicago, as consulting, designing and constructing engineers for the new municipal electric-lighting plant for the city named. The appointment has been unanimously confirmed by the City Council; site has been purchased for the plant and work will immediately start. The estimated cost is $700,000.

MOUNTING PATTERNS FOR SPLIT-PATTERN MACHINE-MOLDING

Exact Matching of Cope and Drag When Made from the Same Gate of Patterns—A New Method That Prevents Offsetting

EDITORIAL CORRESPONDENCE

Fig. 1 will be recognized as a set of patterns mounted for machine molding by the split-pattern system in which the cope and drag are molded from a double set of half patterns, the impression of the right-hand set in the drag matching those of the left-hand set in the cope and similarly, the left-hand set in the drag matching the right-hand set in the cope. Securing these two sets of half patterns to the plate with sufficient accuracy to insure accurate matching of cope and drag will be recognized as a nice job, and it is one before which many patternmakers have fallen down. Correct results are, however, very easily secured by Harris Tabor's transfer-plate method, a description of which follows together with half tones illustrating the method, for the photographic originals of which I am indebted to the courtesy of the Tabor Manufacturing Company.

The first operation in preparing such a set of patterns is to make the pattern plate, including a pair of holes, one of which is shown in Fig. 1 at the end of the gate. These holes are drilled by a jig supplied by the molding-machine makers, and their location defines the center line of the plate. For the case shown four complete patterns are first made, the two halves being doweled together as usual before turning. They are then numbered and separated, and the halves without dowel pins are located on one side of the plate and used as jigs to drill that side of the plate as shown in Fig. 2. The problem then is to repeat the holes thus made on the opposite side of the plate to insure that the locations of the holes in the two sides shall be symmetrical.

To insure this a transfer plate of rather more than half the size of the pattern plate is made. Holes to match the center-line holes of the pattern plate are drilled, the plates are placed together, dowel pins are inserted in the center-line holes, and the two plates are placed under the drill press with the pattern plate on top, as shown in Fig. 3. In this position the pattern plate is used as a jig to repeat its pattern pin holes in the transfer plate.

The transfer plate is then turned over—not around—on the pattern plate, as shown in Fig. 4, the dowel pins are re-inserted, and the transfer plate is used as a jig to drill the holes in the second side of the pattern plate, all as shown in Fig. 5. Removing the transfer plate, the pattern plate appears as shown in Fig. 6, and obviously the second set of holes must be truly symmetrical with the first set and the half patterns when doweled to these two sets of holes—due regard being paid to their numbering—must also be truly symmetrical and produce perfect joints when molded.

F. A. H.

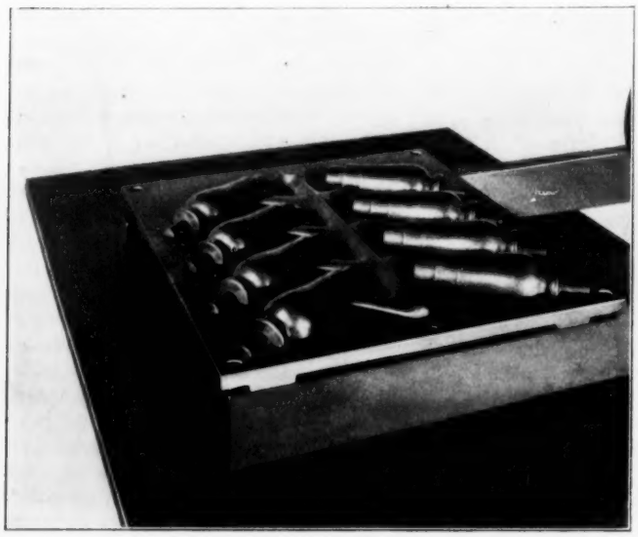


FIG. 1. A SET OF PATTERNS ARRANGED FOR SPLIT PATTERN MOLDING FIG. 2. DRILLING DOWEL PIN HOLES IN ONE SIDE OF THE PATTERN PLATE

A steel floating target, for use at the Sandy Hook proving station, was launched at the Brooklyn Navy Yard recently. It resembles a section of a battleship, weighs seventy tons, and is made of five- and six-inch plates.

Economy in Shop Management—Conditions Leading to Minimum Costs of Production

BY D. C. EGGLESTON

The fundamental principle in finding costs of production is that the articles of manufacture must cancel all expenses incurred in making them. The fewer expenses there are to cancel, the greater opportunity there is for profit. Undoubtedly there is less opportunity for reducing the prime costs, labor and material, than indirect expense. Yet few factories are so well systematized but that there is an opportunity for saving in the prime costs of production.

The introduction of piece and premium work was the first radical move toward obtaining the maximum results from labor. However, even at the present time many shop superintendents have been slow to introduce the best methods of payment. In some cases the wages are so high that the operators are afraid to exert themselves, for fear of a cut in rates. In other cases work is hindered by lack of an efficient system of handling material. To give an operator every incentive and opportunity to produce all the time is conducive to economical shop management. No doubt the expenditure of judicious sums for welfare work is also conducive to increasing the efficiency of the operators. A well lighted shop, warmed, ventilated, cleaned regularly and provided with up-to-date sanitary appliances, aids contentment and harmony, without which all efforts at effecting minimum costs of production are in vain.

Cost-system experts have called the attention of superintendents to the careless methods of handling material. Issuing purchase requisitions, receiving, inspecting, storing and handling material, all offer opportunities for practising economies. The secret of an efficient purchasing department for the shop lies in an adequate system of material records. If there is no internal check on the amount of stock drawn out of stores, there is undoubtedly an opportunity for a saving. In some companies a stumbling block has been overcome by relieving stock clerks of the work of posting stock records and centralizing the work under the direction of the shop-purchasing department. This method is particularly adapted to large plants where store rooms are located in several places about the plant. The system of making out requisitions for material facilitates posting stock-record cards. After posting, the requisitions are filed behind guide cards. At intervals an inventory of the stock on hand is taken from the stock-record cards. The material on hand plus that drawn out, as indicated by the requisitions on file, should equal the amount on hand at the time of the previous inventory plus the amount received since. Great care is required in fixing minimum and maximum quantities of stock to be carried; but, when rightly fixed, there ought always to be a sufficient supply of material on hand and yet not have too much capital tied up in stock.

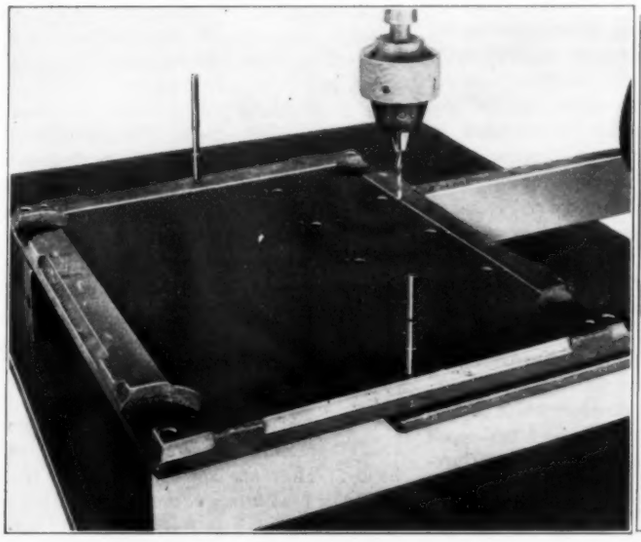


FIG. 3. DRILLING THE TRANSFER PLATE

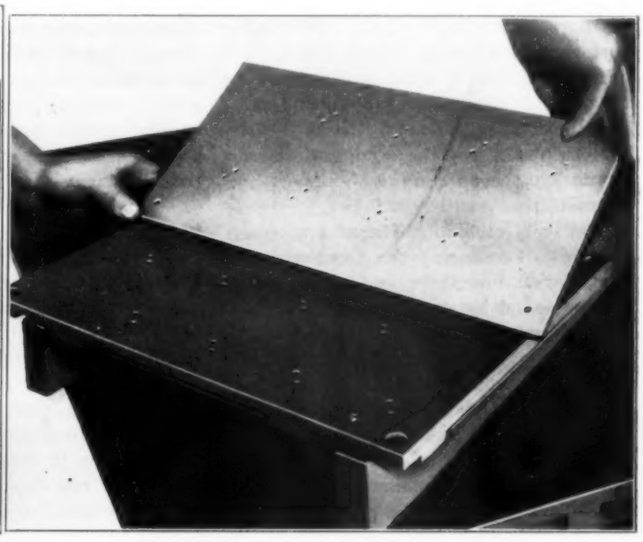


FIG. 4. TURNING OVER THE TRANSFER PLATE

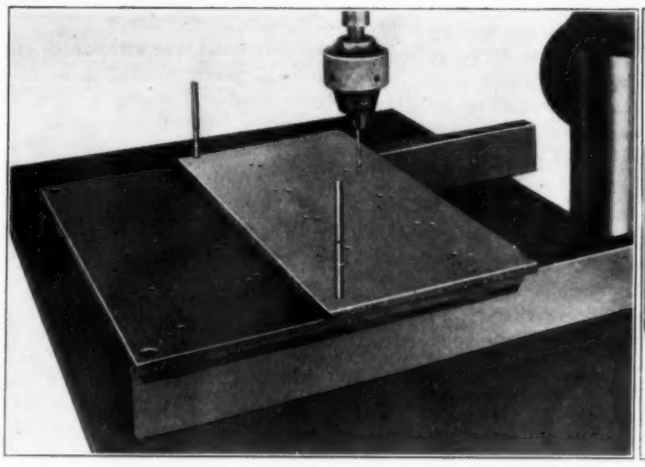


FIG. 5. DRILLING THE SECOND SET OF HOLES IN THE PATTERN PLATE

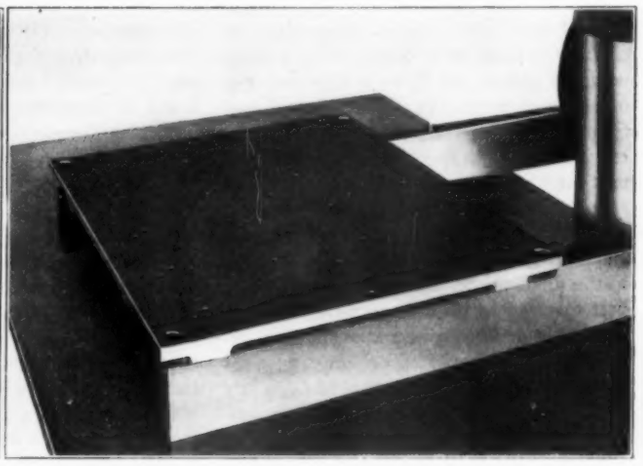


FIG. 6. THE DRILLING OF THE PATTERN PLATE COMPLETED

The best practice is to ask all vendors to put the order number on all bills and packages. This facilitates referring to the receiving department's copy of the purchase requisition in making out the entry slip, which is the office voucher for material received. Requirements of modern machine practice are such that the best results are obtained only when most raw material is rigidly inspected. This insures that material will be as required when wanted. That the maximum activity of productive centers may be obtained, operators require a constant supply of material. In the case of automatic machines an adequate supply of material is of paramount importance. By having porters move all material, it is possible for operators to stay at their machines all the time, which is a source of considerable economy.

Notwithstanding the saving that may be made in connection with labor and material, that possible in indirect expense offsets all others. There are many methods of reducing the fixed charges, depreciation, insurance and taxes, which will be found by studying the best methods of handling plant accounts. The principle in classifying plant accounts is to keep those things the use and depreciation of which is about the same together. However, in considering insurance and taxes, a partial reclassification is required to obtain the minimum rates. Cost-system experts make a distinction between fixtures which may be moved without changing the building, such as racks, shelves and temporary partitions of sheet metal or wood, and the building. This is a good plan, as it makes it possible to class such fixtures with others of a more movable nature and figure a different rate of depreciation than on the building. Since insurance companies are willing to include partitions, racks and shelves as a part of the building and allow a lower rate for insurance, they are best included with the building for insurable values. In making small additions and changes to the plant the resulting charge is usually best assessed against the expense account, thus writing off the entire amount to expense rather than depreciating it gradually.

Non-productive labor is always a considerable item, including as it does all expenses incurred in relieving the productive operators of brain work. Salaries of superintendents, foremen, clerks and the expense incidental to providing them with office space, stationery and so on is a part of indirect expense, usually spoken of as administration expense. In many factory offices a considerable saving has been effected by putting certain classes of work on a piece or premium basis. The introduction of typewriters and adding machines into offices suggested that there was as much reason for paying operators of them according to the amount of work done as operators of machines in the shop. That this has been successfully accomplished in more than one large works justifies others in introducing the system.

Too great attention cannot be paid to the designing and filing of the forms used. Stationery should be adapted for its use the same as any other auxiliary of manufacture. Forms should not be of too flimsy a nature. They should be on paper of sufficient weight to keep their places when filed, and do up into a good bundle. Sizes of forms should be standardized as far as possible and standard filing cabinets should be provided for filing them. Many firms effect a considerable saving by using gramophones for dictation, thus making it possible for typewriters to work all the time.

By exercising care and using the best apparatus the maximum power can be produced for the minimum expense. Then the judgment of the engineer or shop superintendent must be exercised in using it to the best advantage. The power can be used in heating and ventilating the building, in exhausting dust, or applied direct to the machines. The maximum efficiency of the plant is the end aimed at and only the best judgment can derive the most from the investment in power.

Eternal vigilance and constant attention to details is the only way to keep a shop in trim to meet competition. Carelessness in one department sometimes results in expensive mistakes and financial embarassment. The use of antiquated machines and tools is often an unsuspected handicap in the race for minimum costs of production. To control the costs of manufacture is to control the market and to control that is the aim of every superintendent, manager, president and board of directors.

Symposium on Municipal Ownership

Moody's Magazine for October does a good thing we think by the publication of a symposium on Municipal Ownership and Operation, and in doing this it has taken pains to get opinions on both sides, among them opinions from men who have had actual experience as well as those who have given special study to the subject. Among the contributors are Mayor Dunne, of Chicago; Hon. Frederic C. Howe, of Cleveland; Henry Clews, the banker; ex-Gov. Garvin, of Rhode Island; Thomas Commerford Martin, editor of the *Electrical World and Engineer;* Edward W. Burdett, Hon. John Ford, Louis F. Post, editor of *The Public* and William Lloyd Garrison. These contributors consider the subject from every possible viewpoint, and the result is certainly interesting and instructive, for the various writers come pretty near to presenting all the arguments there are on both sides, so that the reader may compare and weigh them. The subject is one of growing import.

Comparison of University and Industrial Discipline and Methods*

The point from which I view college education is that of the employer, not that of the educator. I have had no experience with the difficult and complicated problem that faces the professors and the governing boards of our colleges. On the other hand, I have been engaged for years in organizing the shop, office and commercial management of quite a wide range of engineering and manufacturing establishments. This has brought me into intimate personal contact with a large number of college graduates, and I have become well acquainted with their strong points, which are many, and at the same time with a few of those points in which it would seem that as a class they might be improved. And in what I shall say I have principally in mind the preparation of young men for success in commercial engineering and industrial enterprises; in other words, enterprises outside of the four learned professions.

A POST-GRADUATE COURSE IN THE SCHOOL OF EXPERIENCE

For a period of from six months to two years after graduating they are, generally speaking, discontented and unhappy. They are apt to look upon their employers as unappreciative, unjust and tyrannical, and it is frequently only after changing employers once or twice and finding the same lack of appreciation in all of them, that they finally start upon their real careers of usefulness.

On the other hand, the attitude of employers toward young graduates is fairly expressed by the following written instructions given for the selection of quite a large number of young men to fill positions which presented opportunities for rapid development and advancement. These instructions were to give the preference—first, to graduates of technical schools; second, to the graduates of the academic departments; but to employ no college boy who had not been out for more than two years.

Why is it, then, that these young men are discontented and of practically little use during the first year or two after graduating?

To a certain extent this is unquestionably due to the sudden and radical change from years spent as boys almost solely in absorbing and assimilating knowledge for their own benefit to their new occupation of giving out and using what they have for the benefit of others. To a degree it is the sponge objecting to the pressure of the hand which uses it. To a greater degree, however, I believe this trouble to be due to the lack of discipline and to the lack of direct,

*Abstract of an address by Fred W. Taylor at the dedication of the new engineering laboratory of the University of Pennsylvania.

earnest and logical purpose which accompanies, to a large extent, modern university life.

LACK OF DISCIPLINARY TRAINING

During the four years that these young men are at college they are under less discipline, and are given a greater liberty than they have ever had before or will ever have again.

As to college discipline, it cannot be a good training for after life for a young man deliberately to be told by the university authorities that he can flagrantly neglect his duties sixty times in one term before any attention will be paid to it; while, if in business, the same young man would be discharged for being absent two or three times without permission.

STUDIES SHOULD NOT BE SELECTED BY BOYS

And as to the freedom offered by the modern university system, it is not true that boys from 18 to 20 years old have the knowledge and experience necessary to select a logical and well-rounded course of studies; and even if they had this wisdom, the temptation to choose those studies which come easiest is so strong that it would be unwise to throw upon them so great a responsibility. Nor does it appear wise to leave each student free to study as little or as much as may suit him, at times doing practically no work for days, and at others greatly overworking, with no restraint or direction except the round-up which comes twice a year with examinations. At the least, it must be said that in commercial or industrial life this undirected liberty will never again be allowed them.

During the past 30 years two radical changes have occurred in educational methods. The kindergarten and its accompanying ideas have come for the children, and for the young men has come the change from the college, with its one or two courses carefully selected and rigidly prescribed by the faculty, to the university with as many different courses as there are young men, and in which under the elective system each student is given the choice of all his studies.

The fundamental idea back of the change from college to university is excellent; namely, that of providing a far greater variety in the courses to suit the different tastes and abilities of the students, and to especially prepare them for their future occupations. Accompanying, however, this great step in advance, and yet, so far as I can see, in no way logically connected with it, has come the false step of giving our young men in many ways a greater liberty than is allowed, on the whole, to any other class of active workers; and of handing over to them the final decision in a subject most needing a master mind.

Commercial, manufacturing and other enterprises in which many men coöperate, are managed more and more by delegating all important decisions to a few men whose judgment has been trained through long experience, study and observation in those matters which they are called upon to decide. Yet many of our universities are managed by giving over to the young man, under the elective system, the final decision as to what studies will best fit him for his life's work, although he has, of necessity, but the vaguest idea of the nature of the subjects which lie before him. It is almost like asking him to lift himself up by his boot straps.

I cannot but think that in changing we have modeled largely after the English and German universities, which, as we know, are influenced in their management by traditions handed down through several hundred years; and that in adopting the great university idea of a variety of courses, we have at the same time blindly accepted the foreign idea of the elective system accompanied by a lax discipline, both of which are better suited to medieval times when each man worked for himself than to the present day when the road to success lies through true cooperation.

In this change, also, too great stress has been laid upon those elements leading to knowledge or book learning on the part of the student, and too little upon the development of his character.

NOT TO MAKE THINGS EASY

The kindergarten, also, which has proved so great a help in training the younger children, making them observant and giving them a certain control over themselves, has brought with it one idea which has wrought great harm, and yet this bad idea is in no way properly or logically connected with the underlying principles of the kindergarten.

Somehow the average kindergarten child gets a firm conviction that it is the duty of the teacher to make things interesting and amusing, and from this follows soon the notion that if he does not like his studies and fails to learn much, it is largely the teacher's fault. Now, whatever views the parents or the teachers themselves should hold upon the duties of teachers, there is no doubt that the boys should have firmly in their heads the good old-fashioned idea that it is their duty to learn, and not that it is the duty of the teacher to teach them.

Along with the kindergarten plan of interesting and amusing children, the idea has taken firm hold in a large portion of the educational world that the child and young man should be free to develop naturally, like a beautiful plant or flower. This may again be an excellent view for the older person to hold, but it is a distinctly bad one for the young man to act upon. He promptly translates the idea of developing naturally into wishing to do only, or mainly, those things which he likes or which come easy to him.

Of all the habits and principles which make for success in a young man, the most useful is the *determination to do and to do right all of those things which come his way each day, whether they are agreeable or disagreeable;* and the ability to do this is best acquired through long practice in doggedly doing along with that which is agreeable a lot of things which are tiresome and monotonous, and which one does not like.

Now neither the kindergarten idea, the university elective system, nor the lax college discipline tend to develop this all important habit in young men.

CO-OPERATORS CANNOT WORK UPON THE ELECTIVE SYSTEM

True coöperation, coöperation upon the broadest scale, is that feature which distinguishes our present commercial and industrial development from that of one hundred years ago. Not the cooperation taught by too many among those of our trades unions which are misguided, and which resembles the cooperation of a train of freight cars; but rather that of a well organized manufacturing establishment, which is typified by the coöperation of the various parts of a watch, each member of which performs and is supreme in its own function, and yet is controlled by and must work harmoniously with many other members.

It is a mistaken notion that character of this kind needed for successful cooperation is developed by the elective idea of allowing each boy to choose for himself those things which he will do. It requires far more character to do successfully those things which are laid out for one by a wiser man than to do only what one likes, and in modern coöperation, while the work of each man is modified and more or less controlled by that of others, there is ample scope left for originality and individuality. We must remember that of all classes in the community, college boys are being trained to fill some day the position of leaders in the coöperative field. And there is no fact better established than that the man who has not learned promptly and fully to obey an order is not fit to give one.

An examination of the studies chosen by boys in the university academic departments will show that the logic and motive back of about one-half of the students is that of obtaining an easy course, and even the better students show generally a lack of clear-cut logical purpose in their selection. In their case the studies are chosen because the young man likes or is interested in the subjects, or because they come easy to him, rather than because they give a well rounded and balanced course with a distinct logical purpose. The loose, flabby, purposeless courses chosen by fully one-half of the students under the present system furnish but poor mental diet.

Why cannot all of the good features of the elective system be better attained by permitting each young man to choose in general the object or purpose for which he wishes to educate himself, and then leaving the entire course of studies to the one or more professors in the faculty who are especially fitted to plan a complete and logical course in the chosen field? Let the young man say where he wishes to go, and let the faculty tell him the road he is to travel to get there.

OBJECTS OF EDUCATION

As to the object of college life, some boys are sent to the university to learn how to mingle with men, and to form friendships which shall prove useful and agreeable in after life. Some go there to amuse themselves, and some to get the standing given by a college degree.

Something can be said for each of these objects. Is not the true object of all education, however, that of training boys to be successful men? I mean men successful in the broadest sense, not merely successful money-getters. Successful, first, in developing their own characters, and, second, in doing their full share of the world's work.

Young men should not come to college mainly to get book learning or a wide knowledge of facts. The successful men of our acquaintance are, generally speaking, neither learned nor men of great intellect. They are men, first of all, possessed with an earnest purpose. They have a certain all-around poise or balance called common sense. They have acquired through long training those habits, both mental and physical, which make them masters over themselves; and at all times they have the firm determination to pay the price for success in hard work and self-denial.

SUCCESSFUL MEN

It is singleness and earnestness of purpose that constitute the great motive power back of most successful men, and it is a notable fact that the moment a young man becomes animated with such a purpose, that moment he ceases to believe in the elective system, and in the loose college discipline.

In all earnest enterprises which the students themselves manage, they throw the elective system to the winds, and adopt methods and a discipline quite as rigid as those prevailing in the commercial and industrial world.

The boy who joins the football squad is given no sixty cuts a season, nor is he allowed to choose what he will do. He does just what someone else tells him to do, and does it at the time and in the manner he is told, and one or two lapses from training rules are sufficient cause for his expulsion from the team or the crew.

I say in all seriousness that were it not for a certain trickiness and a low professional spirit which has come to be a part of the game, I should look upon football and the training received in athletics as one of the most useful elements in a college course, for two reasons: First, because in it the players are actuated by a truly serious purpose; and second, because they are there given, not the elective idea of doing what they want to, but coöperation, and coöperation of the same general character which they will be called upon to practice in after life.

Is not the greatest problem in university life, then, how to animate the students with an earnest, logical purpose?

STUDENTS WHO HAVE FACED THE WORLD'S PROBLEMS

In facing this question I would call attention to one class of young men who are almost universally imbued with such a purpose; namely, those who, through necessity or otherwise, have come into close contact and direct competition with men working for a living. These young men acquire a truly earnest purpose. They see the reality of life; they have a strong foretaste of the struggle ahead of them, and they come to the university with a determination to get something practical from the college training which they can use later in their competition with men.

They are in great demand after graduating, and as a class make themselves useful almost from the day that they start in to work.

Neither their earnestness of purpose, however, nor their immediate usefulness, comes from any technical knowledge which they have acquired while working outside of the university, but rather from having early brought home to them the nature of the great problem they must face after graduating. Nothing but contact with work and actual competition with men struggling for a living will teach them this. It cannot be theorized over or lectured upon, or taught in the school workshop or laboratory.

A PLAN FOR PRACTICAL TRAINING BY DISCIPLINE

I look upon this actual work and competition with men working for a living as of such great value in developing earnestness of purpose that it would seem to me, time well spent for each student, say, at the end of the freshman year, to be handed over by the university for a period of six months to some commercial, engineering or manufacturing establishment; there to work as an employee at whatever job is given him, either manual or other work. He should have the same hours and be under the same discipline as all other employees, and should receive no favors. Moreover, he should be obliged to stay even a longer time than six months unless he has in the meantime given satisfaction to his employers.

I believe that there would be but little difficulty in obtaining the coöperation of our business and manufacturing establishments in carrying out this plan, and the University of Pennsylvania, situated as it is in the foremost manufacturing city in this country, would have an especially good opportunity to inaugurate it.

My belief in the benefits to be derived from doing practical every-day work early in the college course is not the result of a theory. It is founded upon close observation and study of young men who have had this experience, and also upon a vivid remembrance of breakfasting each morning at 5:30, and starting to sweep the floor of a pattern shop as an apprentice some 32 years ago, after having spent several years in preparing for Harvard College. The contrast between the two occupations was great, but I look back upon the first six months of my apprenticeship as a patternmaker as, on the whole, the most valuable part of my education. Not that I gained much knowledge during that time, nor did I ever become a very good patternmaker; but the awakening as to the reality and seriousness of life was complete and, I believe, of great value.

Unfortunately, laboratory or even shop work in the university, useful as they are, do not serve at all the same purpose, since the young man is surrounded there by other students and professors and lacks the actual competition of men working for a living. He does not learn at college that, on the whole, the ordinary mechanics and even poorly educated workmen are naturally about as smart as he is, and that his best way to rise above them lies in getting his mind more thoroughly trained than theirs, and in learning things they do not know. All of this should be taught him through six months' contact with workingmen.

Let me repeat in conclusion that our college graduates are the best picked body of men in the community. Yet I believe that it is possible to so train young men that they will be useful to their employers almost from the day that they leave college; so that they will be reasonably satisfied with their new work instead of discontented; and to place them upon graduating one or two years nearer success than they now are; and that this can best be accomplished by giving them an earnest purpose through six months' contact early in their college life with men working for a living; by rigidly prescribing a course of studies carefully and logically selected, and with some definite object in view, and by subjecting them to a discipline comparable with that adopted by the rest of the world.

Philadelphia possesses and is proud of the most notable group of medical schools in this country, and among these that of the University of Pennsylvania unquestionably stands first.

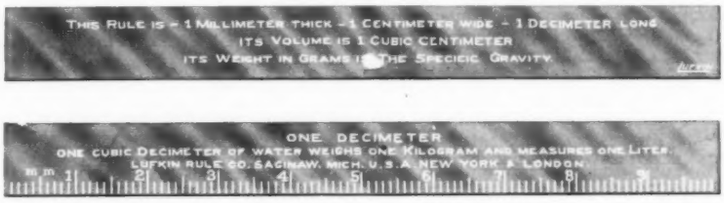
The Philadelphia lawyer has been proverbial for his knowledge and shrewdness

for more than a century, and this reputation can be traced largely to the fundamental training given in the law school of the University of Pennsylvania.

Philadelphia is the center of the largest and most diversified group of engineering and manufacturing enterprises in this country. The engineering schools of the University of Pennsylvania already stand high; but it seems to me that the opportunity lies open to them even more than to their famous medical and law schools to stand at the very top. This magnificent building, equipped as it is with the latest and best of everything, is the first and a great step toward this end. But, after all, your largest possibility, and one which does not exist for, and cannot be created by, any other American university, lies in the opportunity for bringing your students into close touch and personal contact with the men who are working in and managing the great industrial establishments of Philadelphia.

An Educational Metric Rule

We give two views of a steel rule one decimeter long, which rule is designed especially to help those who possess it in familiarizing themselves with the metric system. The inscriptions upon this rule are reproduced in the engraving and explain themselves.


THIS RULE IS – 1 MILLIMETER THICK – 1 CENTIMETER WIDE – 1 DECIMETER LONG
ITS VOLUME IS 1 CUBIC CENTIMETER
ITS WEIGHT IN GRAMS IS THE SPECIFIC GRAVITY
ONE DECIMETER
ONE CUBIC DECIMETER OF WATER WEIGHS ONE KILOGRAM AND MEASURES ONE LITER.
LUFKIN RULE CO. SAGINAW, MICH. U.S.A. NEW YORK & LONDON.
m m 1 2 3 4 5 6 7 8 9

A DECIMETER RULE

It may be remembered that a number of the letters which we have published in our columns, written by men who have had experience in machine construction with both the English and the metric system of measurement, have included a statement to the effect that it is much easier for one to become familiar with and to think in metric units than is usually imagined to be the case by those who have not tried it.

Of course, it is equally true that the best way to become familiar with new units of measurement and to learn to think in them is to use them, and a little use of the rule illustrated, particularly if a few guesses are made of the dimensions of familiar objects in decimeters, centimeters, or millimeters, and then those objects are measured with this rule, will show that it is usually quite easy to acquire more or less familiarity with metric dimensions. The rule at the same time illustrates the coherency and the systematic order of the metric units. It is one decimeter or ten centimeters, or 100 millimeters long, one centimeter wide and one millimeter thick, it contains one cubic centimeter of steel, and its weight is, therefore one gram (or one-thousandth part of a kilogram) multiplied by the specific gravity of steel. The overall dimensions of the rule, when tested by a metric micrometer, we find quite accurate. It is encased in leather for the pocket and is made by the Lufkin Rule Company, Saginaw, Mich.

Machinery in India

STEADILY INCREASING DEMAND FOR SMALL MACHINES, PREFERABLY FOR FOOT OR HAND POWER, PROMISING FIELD FOR AMERICAN ENTERPRISE

In India the prime requisites in machinery are simplicity, solidity and cheapness. Labor is so cheap that in many cases it does not pay to put in a power plant of any kind.

Among the manufactures for which a permanent and reliable market now exists in Bombay are small forges, lathes, drilling, planing, punching, shearing, and similar tools that can be operated by hand or foot. The manager of a leading importing house says that the use of lathes operated by foot power and of drills is increasing, and that the American manufacturers would add to their sales if they paid more attention to providing their products with feet, so that the machines could be fastened to the bench. Most drills now forwarded are for fastening to a post or wall, but the Hindu wants them attached to the bench, since that conforms better to his manner of working.

SOLIDITY PREFERRED

Some small power drills have been imported from the United States, and have given satisfaction; but the larger sale is for the hand drills. The great body of the consumers are not able to provide themselves with power. It is suggested that in all kinds of metal-working machinery intended for India, the American manufacturers should consider solidity rather than lightness of finish or novelties in the way of improvements.

For generations the only pattern known to the Hindu has been of the heavy British type; and while he is not averse to availing himself of improvements, as is shown by the market that has arisen for the American metal-working tools, he takes most kindly to those which are of the soliest pattern. So long as increased efficiency can be demonstrated, it is better not to insist on offering him the further advantages of finish, and what the British importers of machinery call "Yankee gimcracks." It may be added that a technical physical demonstration is all that counts with the Indian buyer. Illustrations, descriptions, and the fluency of the most persuasive salesman go for nothing, unless all that is claimed can be shown before his eyes. A working model is essential.

CARELESS PACKING

The complaint about careless packing is universal. Machinery, as a rule, has to be shipped "knockdown," and some of the exporters apparently in packing the parts consider that several thousand miles of ocean transportation calls for no more care than if the machinery parts were to be sent across a ferry. Almost invariably the lumber used is too light. For machinery of whatever kind destined for India, stronger lumber should be used, and the covering should be bound by iron hoops. I do not enlarge on this subject, because in the matter of packing India is simply another chapter in the familiar book of American backwardness in meeting the requirements of foreign trade.

CATALOGS AND CORRESPONDENCE

While seeking business by means of correspondence, catalogs, and similar indirect methods is unsatisfactory, nevertheless, in view of the very limited experience of the Indian factories with the use of American machinery, a preliminary step toward interesting them, especially in mill accessories, might be taken through the mails and be followed up by traveling salesmen. The majority of the weaving and spinning mills are members of the Bombay Millowners' Association, some of whose leading members are anxious to secure active competition in place of the present dependence on the British manufacturers of mill machinery. For the manufacturers in the United States who may care to open correspondence, a list of the different companies in Western India, with post office addresses, is forwarded to the Bureau of Manufactures. In the list of cotton mills the number of looms and spindles shows the size and relative importance of the different factories.

NOTE—Copies of the list may be obtained by addressing the Bureau of Manufactures, Department of Commerce and Labor, Washington, D. C.

The alloys of lead, tin and bismuth show peculiar properties. A mixture consisting of the following:

Bismuth .....2 parts
Tin .....1 part
Lead .....1 part

melts at a temperature slightly below the boiling point of water. It also expands on cooling so that it is quite suited for taking delicate impressions of dies, etc.

ENGINEERING INDUSTRIES IN RUSSIA—III

Wages and Expenses Low—Inadequate Equipment—Workshop Conditions Unsettled—Relations of Employer and Workmen.

BY CHARLES PRESCOTT FULLER

Like the poor, the wages question is ever in evidence, in Russia, as in other lands, and similarly it is the main question in all disputes, all other points being subordinate to wages. While the salaries of managers and foremen are comparatively high, the wages of workmen generally are low, by comparison with those of other countries. The reason of this primarily is not far to seek; it lies in the sharp division of the administrative classes from the working classes which has existed from times immemorial.

WAGES AND COST OF LIVING

While the administrative classes have to pay excessive rents for house accommodation, all classes of household goods, apparel and items of general comfort such as they need, in addition to being the chief source of taxes, both direct and indirect, the working classes, omitting those engaged purely in agricultural pursuits, until recently have had none of these heavy expenses. Very many own their own small houses, the yards of which may in addition contain other small houses let out at small rents to other workmen, not so fortunate, and these again let a room or two to unmarried workmen. These houses may not be what abroad would be considered hygienic or with handsome exteriors, but they are cheap, and the taxes in connection therewith are very small. There is no lighting rate, no police rate, no water rate, no highway rate and no poor rate; such do not exist. So far as clothing is concerned, the working classes do not spend much; they live in the very simplest manner, and if they would drop vodka, quite inexpensively. The cost of all comestibles has, it is true, been increasing of late years, but living is still cheap. It is these two diverse conditions combined that have kept wages low in Russia, while administrative expenses of a works remain high. Another way of looking at this latter is by comparison of the needs of the educated and administrative section of the population on the basis of the money units in different countries; as these units are higher or lower, so is the cost of living of this class. In Italy and France, where the unit is low, the cost of living is low; in Germany and England slightly more costly; in Russia it is about double that of England, and in America double again that of Russia. A dollar United States is equal to two roubles, and a rouble is equal to slightly more than two shillings or two marks, taking the value of pounds sterling at exchange rates.

The wages of artisans and laborers in Russia vary as elsewhere, according to locality. In one district or town they are higher or lower than in others, without any seemingly tangible cause. Laborers earn generally from 60 to 80 copecks, that is equivalent to from one shilling three pence to one shilling eight pence per day, and they are generally paid by the day. In foundries, rolling mills and where very heavy work is needed, they earn up to an average of from one shilling ten pence to two shillings eight pence. Among artisans the best paid workmen, or perhaps one should say those who earn the best wages, are molders and blacksmiths, which is as it should be, considering the strenuous nature of their work, and the general drawbacks of these trades such as heat, smoke and dampness. Good molders and smiths, nominally rated at from two shillings two pence to five shillings per day, are mostly on piecework, and earn anywhere up to 60 shillings per week of 55 hours. The average of say 30 per cent. of these workmen in any given works earn about 45 shillings per week. Next to these come turners, who are nominally rated also at from two shillings two pence to six shillings per day, and they likewise on piecework earn from thirty shillings to forty shillings per week, according to locality. Fitters and joiners, nominally rated from say two shillings two pence to five shillings, five pence per day, earn anywhere from twenty-six shillings to thirty-six shillings per week. Patternmakers are not so much on piecework, and are paid from one shilling seven pence to five shillings five pence per day, the latter being more the exception than the rule. Instrument fitters can earn from three shillings three pence to six shillings per day on day work, according to skill, and in this branch of late great improvement has taken place, in spite of lack of precision instruments for construction and measurement. Patternmakers are the greatest stumbling block. It seems an absolute impossibility to get these men into a quick and economical way of working. They are mostly recruited from joiners who have their set ideas of how to do a job, and from these ideas nothing will shift them. Lads taken on to learn this trade follow their elders, and so it goes on.

It is a pity that this branch fails to grasp the fact that they are or rather should be, the leading trade and best paid in a works, and try to raise themselves to it by getting into modern methods of working; they just won't, and there they stick. A good English or American patternmaker will do nothing by hand that he can possibly do on the machines at his disposal; the Russian insists on doing every mortal thing by hand, and in the most tedious way, while the machines stand idle half the time.

In general, the Russian workman is a strong, healthy individual, and when on the piece, works hard and earns good money. If he would use his head more, and puzzle out ways of relieving his arms and hands when at work, he could, in most cases, earn still higher wages, even at reduced prices; but as yet this use of brain power is very seldom exercised, and he goes blundering along at his work, getting out plenty, and never worrying as to its quality, or how much easier his work could be done.

INADEQUATE WORKSHOP APPLIANCES

A few words will be in order relative to workshop appliances. Until very recent years, it may be safely said that such did not exist, unless the wretched makeshifts are reckoned as such. Lifting tackle for heavy weights, in foundries, etc., have always been in evidence, but even now in hundreds of works these are the most primitive of their class, though in the more modern plants, they are fairly satisfactory; but seldom in these even, except over the very heaviest of tools, does one see handy little blocks and runs, so that the workman can himself lift his 100-pound piece to his lathe or other tool. It is quite common to see three or four men round a tool putting such a piece on the face plate, or between centers; two will do the work, and two will help by "looking on." Foremen pay little attention to this and should the manager appear the "helpers" will immediately be busy uselessly, fooling with a bit of wood, or something of the kind to show how hard a job they are all sweating at. Should a visitor ask why this sort of thing occurs, the answer generally is, "Oh, blocks and such luxuries cost money and are always out of order, besides the men would not use them if they had them." Quite possibly where this sort of thing occurs the works are making money, and plenty of it, but how much do they miss making thereby? That does not seem to matter. Then again tote boxes on wheels one sees but in few shops; everything is moved from machine to machine, from place to place, anyhow, with no logical system. There are no work stands, or provision for finished work, which is for the most part thrown on the floor there to lie and get mixed up with chips and waste and for everyone to walk over or, more likely than not, fall over; there it lies till somebody wants it. Men run around hunting for the parts each requires. If a piece is spoiled the workman sticks it behind his bench, or in any dark corner and goes off again on a prowl round for one to re-

place it. Where hundreds of parts of one sort are used, there is no end of trouble when a job is coming to conclusion. Half the shop is searching for what has long since been melted or sold as scrap and after much wrangling and talk new parts to complete the order must be made; there is no other way.

JIGS, FIXTURES AND GAGES

Jigs and templets, again, are in hundreds, nay thousand of cases, made of scrap, with no design and anyhow, so long as they are cheap; blocks of wood are hacked out for certain castings of irregular form, and when the pieces for which they are made are run off, they are chucked into the rubbish heap. If of metal the jigs used in many shops are as primitive as possible. Seldom indeed are they made interchangeable relative to machine tools. When done with they are chucked on the floor near the machines and when next required lie beneath a pile of finished work, castings or rubbish. It is often argued, why pay much attention to such jigs, possibly the next order may require alterations of the part for which they have been used. But even so, a properly constructed jig with some little thought and foresight used in designing can be altered to suit some changes in parts. Very often the man at a machine has to rig these jigs up himself and nice messes they generally are, or the foreman makes a rough sketch and gives it to his handy man, who being a day worker spins it out and perhaps adds his own ideas. When it comes to be used, it has to be scrapped and another one made. In shops where these practices exist, there is no record book of tools and appliances, and no system of checking their loss, etc., but what about the cost?

Standard gages generally are no longer standard, and have been tinkered and abused till there comes a time when nothing goes together as it should. Limit gages are little used, simply because their use is but partially understood. They are considered fads; "Our men can't use them properly," or some such twaddle explains their non-use. Control gages where they exist are placed maybe under lock and key in the manager's office and of course are precious little use there. It is no part of a manager's duty to give out tools, even control gages. This is much on a par with the old way with twist drills in England years ago. There they would have one or two in a glass case in the general office to point out to visitors, as a sort of "totem," but "use 'em, no sir, they cost a pile of money."

TOOL-ROOM PRACTICE

In the opinion of modern engineers, on modern requirements, these control gages are for use *all the time*, and should be in the tool shop under the control of a first-rate man paid a good salary to see to it that they are used for the purpose for which presumably they are bought.

Naturally in many Russian workshops this practice of having a proper tool room exists, but in very few is it carried out as it is in England, America, or Germany, for instance. The places are provided, put in charge of a fitter and left largely to run themselves. Naturally they then do really more harm than good and are an endless source of expense and worry. In the countries named, on the contrary, the tool rooms are, almost as much as the drawing office, the brains of the mechanical departments and if those in charge should let things get slack, they would be discharged and replaced by more competent men. The fact is, Russian workshop practice at present, like Russian political practice, is in a state of semi-chaos. It is passing through a transition period, and it will take long to bring into it the skill and finish to be found elsewhere. Those firms who fully recognize this are striving to accomplish better results in their works, and in time they will succeed and continue flourishing, but those who do not recognize this, or from parsimony won't, must fall into an insignificant place and eventually succumb altogether.

It is ever the law of evolution in action, resulting in the survival of the fittest in this matter, as in nature.

FACTORY LAWS

Like other nations Russia has her factory laws, and very advanced factory laws; far too much so for the state of her manufactures and the condition of her workmen. Those laws, made specially for the benefit of and in the interests of the employee, press very heavily on the employer in Russia; not that they are in themselves bad in conception, but rather that they have been badly drafted, probably by people in high places who never saw the inside of a works, much less had any experience in dealing with workmen in large bodies. Where entirely clear the law is on the side of the men and where not clear both sides are at the mercy and judgment of inspectors or magistrates whose decision one has to abide by, and where there is the slightest question of points not being legally clear, decisions in 99 cases out of 100 are given in the workmen's favor.

WAGES BOOKS

New workmen engaged, if kept longer than seven days, must then be furnished with a wage book, the front page of which has printed upon it the firm's name and address, spaces for the engaged workman's full name and trade, nature of his engagement, date of engagement, and rate of wages, notice of and date of discharge. The body of the book is made up of pages lined for wages due on one side and wages paid on the other. Also the firm's own factory rules are included and the chief sections of the factory laws relative to employer and workmen, sickness, and compensation for injury. Into these books all wages earned, whether by time or piece, or bonus, or advances on account of wages, must be entered by the wages clerk before each payment and the books with money due handed to the workmen on pay day, which may be weekly or fortnightly as the firm may decide, but must be at intervals of not more than one month. No deductions are allowable by law from workmen's wages, except fines, the list of which must be certified by factory inspectors, embodied in the firm's private rules and hung up in each workshop. Money advanced on account of wages cannot be legally deducted unless previously entered in the wages book at the time of advance on a page specially set apart for the purpose. The law also precludes all truck payments, i.e., payments in kind, and no deductions are permissible from wages for goods of any kind supplied to workmen, except under certain exceptional, specified circumstances, legally defined. These wages books must always be in the possession of the workmen themselves, except for time necessary for entries of wages and payments; should a workman lose his book he must give notice of his loss to the office and a new one is issued for which he must pay, the sum being generally 20 copecks (about 5 pence). This wages-book system would be a really good thing if it were not rather a one-sided arrangement. It is legal evidence for a workman in all cases of disputes and also for the firm, but that is about all. Why in framing the law that portion relative to these wage books was not carried a step further in equity is not clear. For instance, if a workman starting at a new job were *compelled* by *law* to produce his wages book from his previous employment, what a boon it would be to all concerned, especially to good workmen. It would be a check upon bad characters and wasters and tend to make them careful as to how they conducted themselves.

To make the system complete a photograph of the holder of the book should be bound in it, and firms forbidden to accept workmen without such books. On the other side, the law should compel employers upon discharge of a workman, or his leaving, to state truthfully why he leaves their employ, his conduct while with them, his skill as a workman—fair, good, or excellent and whether he has improved in skill or character while in their employ if the period of service were of longer duration than, say, six months. But, unfortunately, both for workmen and employers, these desiderata do not exist; their omission shows just where drafters of factory laws fail to grasp the needs of both parties interested.

In addition to these wages books, and the ordinary office time books and wages-calculating books that are usually to be found in all works, Russian law compels employers to keep a workman's ledger. Into this the name of each individual employed is entered with a separate account

to which are booked all sums earned and due to be paid to him or her on one side, and all payments made on the other—a regular debit and credit account. In large works this means a separate clerk, with assistants if necessary, just for this one ledger. This book is not only a safeguard to both sides if a workman loses his wages book but is an official record of his earnings in any cases of ordinary disputes, or for computing compensation for injury.

Employers must also keep an official register in which are entered the names and addresses of every employee they engage, his trade and all particulars of workmen's passports, which must be handed in for this purpose by the workman before he starts on his new engagement. After the entry is made the workman's passport is now generally returned to him immediately, though formerly these documents were held by the firm, and the firm had to see to their periodical renewal. Upon a man's discharge, of course, his passport was returned to him, he giving a receipt for it to prevent future disputes.

ENGAGEMENT AND DISCHARGE OF WORKMEN

To present the relations of employer and employed to each other more clearly with respect to the principal terms of *actual* engagement and discharge of workmen, perhaps it will be simpler to state literally the Russian statutes relative thereto, as they exist today:

"Engagement of workmen is effected: 1. For a definite period. 2. For an indefinite period. 3. For a period to execute any work, the completion of which itself determines the period of engagement. In the case of engagement under the second heading, the same may be canceled by either of the parties to the engagement giving the other 14 days' notice of such.

"Before the actual conclusion of a determined period of engagement of workmen" (as under 1, for instance) "or without giving 14 days' notice in cases of engagement for undetermined periods" (as under 2, for instance) "it is forbidden to lower the rates of pay, or make any new conditions of curtailing them by shortening number of work hours per week or per day, or by change of the rules affecting work hours and so forth. The workmen in like manner are forbidden to demand any changes in the conditions of their engagement." (That is, without 14 days' previous notice.) "The contract of engagement between employer and workman may terminate: 1. By the mutual terms of an engagement. 2. By expiration of the time for which the engagement was made. 3. By conclusion of the work the fulfilment of which terminates the engagement. 4. By two weeks' notice on either side, from date of notice, of the wish of either party to terminate the engagement, if made for an undetermined period. 5. By the expulsion of workman by the authorities from the place where the engagement was made, or by arrest for such period as makes the fulfilment of a contract of engagement impossible. 6. By the necessity of military service, or of his services for the authorities. 7. By the refusal of the authorities to renew a workman's passport. 8. By stoppage of works by fire, flood, boiler explosion or similar unforseen accidents.

"The works administration may terminate engagements with workmen: 1. In the event of a workman absenting himself from his work for three *consecutive* days, or an *aggregate* of six days during a period of one month, without justifiable cause. 2. In the event of a workman being absent from his work for two consecutive weeks even if the cause of absence is justifiable. 3. In the event of a workman acting in such manner as would render him liable to criminal prosecution, carrying a sentence of imprisonment. 4. In the event of a workman being grossly impudent, or so acting that the material interests of the firm are endangered, or the person of any employee of the superintending staff of works administration threatened. 5. In the event of a workman being found suffering from a contagious disease.

"*Note*—Causes for dismissal as set out in clause 4 include among others, carelessness with fire, also smoking tobacco, or having on the person, matches, pipes and cigarettes, in such works, or in departments of any works, which being made known by a firm to the council for factory inspection, have been officially confirmed as improper places for admitting such articles or acts.

"*Note*—Dismissal summarily for any of the foregoing causes may be disputed if brought before a court within one month of the dismissal, and should the dismissed be able to show himself not in fault to the court's satisfaction, his employer must recompense him for his lost time, in full."

Russia.

We have received a catalog issued by the Providence public library, giving classified lists of books and periodicals for workmen in the three leading industries of Providence, viz., textiles, jewelry and silversmithing, foundry and machine-shop work. The date and catalog number of each publication is given, with a brief comment on its scope. Such a pamphlet should be of great benefit to parties interested in these subjects, and the example of the Providence library is well worth imitation by others.

The Joseph Dixon Crucible Company (Jersey City, N. J.) has published a pamphlet entitled "Unions for Steam Pipes," by W. H. Wakeman. It contains 24 illustrations of several varieties of unions, and many useful remarks with reference thereto. The pamphlet is a reprint from the Dixon publication *Graphite*, and copies may be obtained from the company named, free of charge, by any engineer, or interested party.

The Conditions of Fan-blower Design

The velocity with which air escapes into the atmosphere from a reservoir is dependent upon the pressure therein maintained, and upon the density of the air. The pressure per unit of area, divided by the density per unit of volume gives the head, usually designated as the "head due to the velocity." The velocity produced is that which would result if a body should fall freely through a distance equal to this head. In the case of the flow of water such a head always exists; as, for instance, when a stand-pipe is employed to produce the requisite pressure. Suppose the head of water to be 50 feet, and its weight per cubic foot to be 62.5 pounds, then the pressure per square foot will be $50 \times 62.5 = 3125$, and that per square inch $3125 \div 144 = 21.7$ pounds. Its theoretical velocity of flow from an orifice at the bottom of the stand-pipe would be 56.7 feet per second, as determined by the formula for falling bodies, which is $v = \sqrt{2\,g\,h}$ in which

v = velocity in feet per second.
g = acceleration due to gravity.
h = head in feet, here 50 feet.

In the case of air, however, an actual homogeneous head never exists, but in its stead we have to deal with an ideal head, which can only be determined by dividing the pressure by the density. As the density of air is so much less than that of water, it is evident that for a given pressure the head will be far greater in the case of air. But the velocity of discharge is dependent only on the distance fallen, which is represented by the head, whether real or ideal. As a consequence, air under a stated pressure escapes at vastly higher velocity than water under the same conditions. Calculated in the same manner, the velocity of escaping air under a pressure of 21.7 pounds per square inch is 1626 feet per second. The B. F. Sturtevant Company, which has supplied this discussion, has employed formulas based upon this theory for the calculation of the elaborate tables which they have published. It is evident from the foregoing that the pressure created by a given fan varies as the square of its speed. That is, doubling the speed increases the pressure fourfold. The volume of air delivered is, however, practically constant per revolution, and therefore is directly proportional to the speed.

The work done by a fan in moving air is represented by the distance through which the total pressure is exerted in a given time. As ordinarily expressed in foot pounds, the work per second would, therefore, be the product of the velocity of the air in feet per second, the pressure in pounds per square foot, and the effective area in square feet over which the pressure is exerted.

From this it is evident that the work

done varies as the cube of the velocity, or as the cube of the revolutions of the fan. That is, eight times the power is required at twice the speed. The reason is evident in the fact that the presssure increases as the square of the velocity, while the velocity itself coincidently increases; hence, the product of these two factors of the power required is indicated by the cube of the velocity.

The actual work which a fan may accomplish must depend not only on its proportions, but upon the conditions of its operation, and the resistances which are to be overcome. Evidently, it is improper to compare fans when operating under such conditions that these resistances cannot be definitely determined. The simplest and most natural condition of operation is that in which the fan is operated without other resistance than that of the case; that is, with open inlet and outlet. For proper comparison of different fans, the areas through which the air is charged should bear some constant relation to the dimensions of the wheels themselves.

It has been determined experimentally that a peripheral discharge fan if inclosed in a case, has the ability, if driven at a certain speed, to maintain the pressure corresponding to its tip velocity over an effective area which is usually denominated the "square inches of blast." This area is the limit of its capacity to maintain the given pressure. If it be increased the pressure will be reduced, but if decreased the pressure will remain the same. As fan housings are usually constructed, this area is considerably less than that of either the regular inlet or outlet. It, therefore, becomes necessary, in comparing fans upon this basis, to provide either the inlet or the outlet with a special temporary orifice of the requisite area and the proper shape, and make proper correction for the contracted vein. The fan is thus, in a sense, placed in a condition of constriction of discharge, which it approaches in practice only in so far as the resistances of pipes, passages and material through which the air must have the effect of reducing the free inlet or outlet of the fan.

The square inches of blast, or, as it may be termed, the capacity area of a cased fan, may be approximately expressed by the empirical formula:

$$\text{Capacity area} = \frac{D\,W}{x}.$$

In which D = diameter of fan wheel, in inches.

W = width of fan wheel at circumference, in inches.

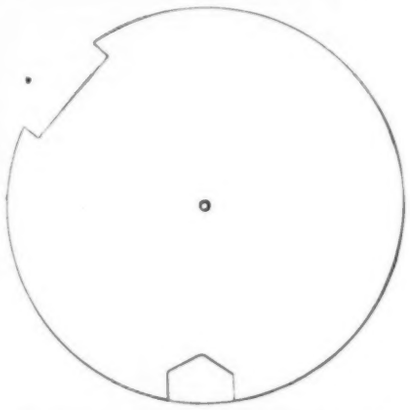
x = a constant dependent upon the type of fan and casings.

The value of x has been very carefully determined by the B. F. Sturtevant Company for different types of fans; but these values must be applied with great discretion, acquired through experience and a thorough knowledge of all the conditions liable to affect the fan in operation.

Fractures of Axles Originating in Drilled Holes

There are an increasing number of railroad cars in the United States lighted by electricity generated by a dynamo carried on the car and driven by belt or chain from a pulley on one of the axles of the car. We believe that it is pretty generally understood here that it is not good practice to drill any hole in the axle in applying such an equipment; it does not appear that the danger of doing so has been heretofore universally recognized on the other side, judging from a paper read before the English Institution of Civil Engineers by Lucien Alphonse Legros on the subject which forms the title to this article. Mr. Legros says:

"It is well known that in many materials a drilled hole will prevent the spreading of a crack, and the extension of a crack in a casting or forging is frequently stopped by this means; but the fact that in some cases a drilled hole may



OUTLINE OF THE BROKEN SECTION OF THE AXLE, SHOWING DRILLED HOLE

cause the commencement of a crack does not appear to be so generally appreciated.

"Cracks may be expected to appear in a material subject to alternating stresses, at places where there is an abrupt change of section, or where a notch or groove has been made by a cutting tool in a turned surface. Locomotive engineers have for many years past recognized the importance of these details and their influence on the life of both cranked and plain axles."

Mr. Legros presents photographs of two fractured tramway-car axles which he had examined in 1897, the fractures having occurred through the center of shallow drilled holes. The first axle failed while at work after running 15,380 miles, and the second one after running 13,900 miles, the crack having been detected before the fracture took place. The steel from which the axles were forged was made to British railways standard specifications, the mean axle load was 5 (long) tons, and the diameter of the axle at the fracture was in each case 3¼ inches; the cracks occurred several inches from the key-seat and at points where the stress would not be the maximum. The drilled hole was made to receive the point of a set-screw to prevent endwise motion of a chain wheel. We show herewith an outline of the broken cross-section of the second axle, showing the location and relative proportions of the key-seat and drilled hole. The lesson learned from this accident resulted in the use of pairs of clamp-plates gripping the axle and bolted to one another instead of using set-screws.

In 1902 a similar case came under the observation of Mr. Legros; this was the failure of an axle in service on a suburban passenger train near London, the set-screw having been drilled to prevent movement of the driving gear for the electric-lighting plant. Other cases of failure originated in an oil-hole drilled in a shaft at the center of a journal to meet an axial hole conveying lubricant from the end of the shaft, this being a construction not unusual in crank pins and journals with certain forms of forced lubrication. He considers that the risk would be greatly reduced by rounding off the top of the hole so as not to leave any sharp edge.

Where the very undesirable practice of drilling holes in axles or shafts has been followed these parts should be carefully examined to detect any signs of fracture as soon as they appear.

A Home-made Hydrostatic Level

During the construction recently of a 60x100-foot addition to his shop at Brighton, Mass., Edward Rivett decided to test the accuracy of the work on the walls which was being carried along by the aid of the regular leveling instrument, and for this purpose he constructed a novel water level. Six water pails were secured, and four of these were placed at the corners of the walls, while the other two were put midway along the side or 100-foot walls. One hundred feet of piping was then placed midway between the two rows of water pails, and branch pipes were extended crosswise, thus connecting each pair of pails with the main pipe, and through this, with each of the other two pairs also. Water was then poured into the system, and upon the liquid having assumed its level in the six pails, it was found by inspection and measurement, that one corner of the work was about one-quarter inch low. The leveling instrument, which had been used previously, was then tested, and found to be out slightly, and upon correction it naturally revealed the same imperfection as that detected by the home-made level.

It is said that the largest pin factory in the world is in Birmingham, England, its output being 37,000,000 pins daily.

Molding Submarine Pipe

The accompanying sketches show the method followed in pipe foundries for molding submarine pipe vertically in dry-sand molds. The style of joint shown in Fig. 1 is known as Ward's joint and is the one most extensively used. These

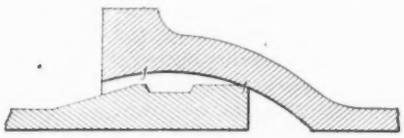


FIG. 1. WARD'S PIPE JOINT

pipes are used principally for the transmission of water and gas under water and are much heavier than the connecting land pipes to offset the buoyant effect of the water. The ball and socket joint is used so that the pipe can adapt itself to the contour of the river bed. The pipes are made in lengths of 12 feet and under and have a maximum deflection of 15 degrees. The bells are machine bored and the beads are turned at the point of contact with the sphere of the bell.

MOLDING

The bell pattern and ramming ring, Fig. 2, being placed on a bed plate, the flared end, which is in halves and steady-pinned to ramming ring, is put in place and rammed up with sand to joint *A*. The main flask is then placed on the flared end and clamped to place, and ramming of the sand is continued to a point that will give a bed for lower part of the head ring (which is made in six segments and so cut as to draw radically from the mold) which is next located, followed by the print ring. The bead ring is held in place by the print ring over which the buttons which are set screwed to the bead ring lap. Ramming of the remainder of the flask is next completed. The main body pattern is first drawn, after which the whole flask is hoisted from the floor sufficiently to allow the bell pattern to be drawn, bead and print rings being next drawn in the order named. The ramming ring is then unclamped and the sand bottom clamped on.

BLACKENING THE MOLD

The blackening plug, Fig. 4, is held below the bead of the mold and the blacking, which is in liquid form, is poured on the plug quickly enough to form a basin. The plug is then given a vertical as well as a rotary motion by hand, which causes the blacking to descend the wall of the mold in a spiral direction. The bell and bead ends are blackened with a hand brush.

THE CORES

Fig. 5 shows the core box, bell ring and former for making the bell end core and explains itself.

Fig. 6 shows a plan of the covering core, five gates being shown in this case, of which four are equally spaced. The gate shown at *H* is used for a riser and blow gate and serves the double purpose of a riser and a means of escape of the air from the mold.

Fig. 3 shows the mold ready for pouring. The main core barrel rests on the bell ring, both being machined to the same angle. The part of the bell core that projects above the bell ring is made so as to clear the print of the main core 1/16 inch all around so as to avoid crushing in case of any irregularities in the print. The top end of the main core is centered with the core gage shown in Fig. 7, as follows: After the main core is lowered to place, the covering core is placed in position. The dimension *F*, Fig. 6, is made equal to the thickness of metal in the casting. The dimension marked *G*, Fig. 6, is made ⅛ inch greater than *F*, Fig. 7, so as to admit the gage entering the mold, *K*, Fig. 7, being also ⅛ inch less than *H*, Fig. 6, for the same reason. The core gage is entered into the mold through each of the four gates in succession and given a quarter turn which brings face *F* in a radial direction. When the main core is centered, four small wooden wedges are inserted in the space between it and the covering core so as to hold it to place. The casting is stripped by first removing the sand bottom and then driving a wedge in the joint of the flask opposite the lugs, thus opening the flask sufficiently to allow its being hoisted from the mold.

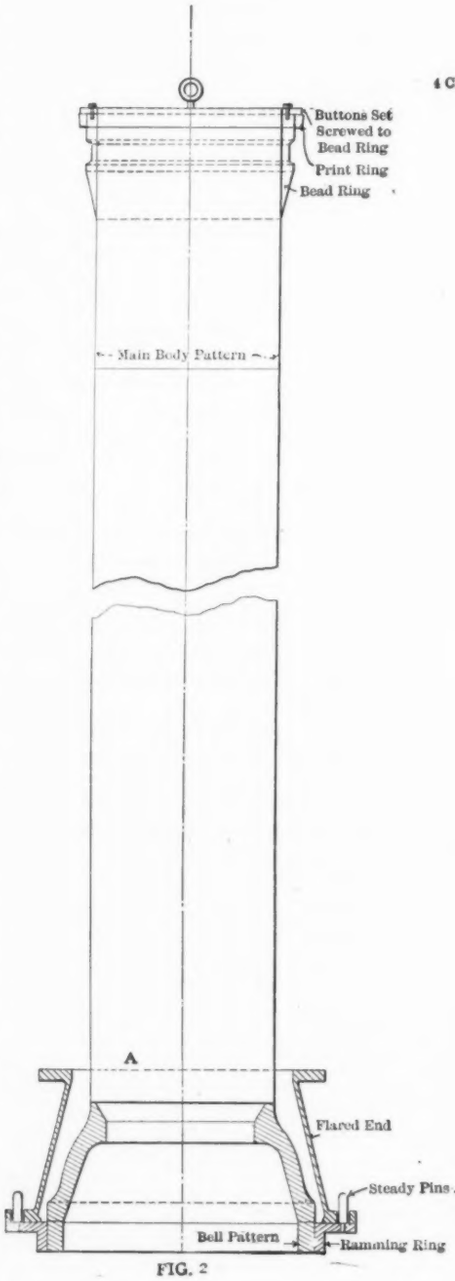


FIG. 2

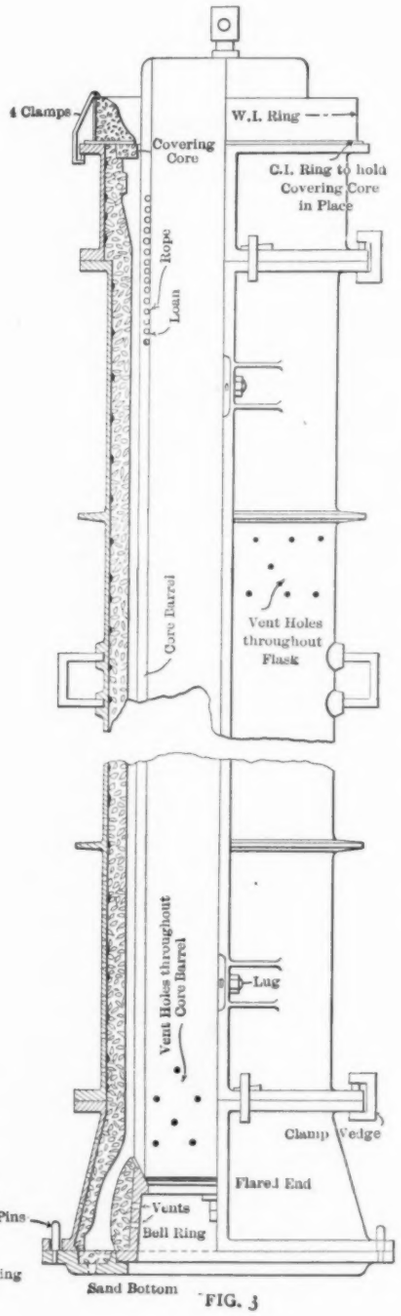


FIG. 3

Markets for American Machinery Abroad—Aids to the Getting and Keeping of Them

There is one sentence in the report of Mr. Bell, the British commercial attaché in the United States, that is worth quoting here. He says that there is a demand for high-class cutlery, etc., in America as well as for those goods of cheaper make. He adds that to show this is so "it is only necessary to mention that within the last few days a letter has been received from the State of Washington asking for the names of manufacturers of the *highest grade* edge tools in the United Kingdom. The writer states that he can no longer get the desired quality in the United States." It would be interesting to learn at what period it became possible to obtain "the highest grade edge tools" in the United States, and exactly what is the reason for the decline in the quality of this class of manufacture. Obviously there is a demand for such goods, and it is certainly curious that an American buyer could not obtain the "highest grade" from American makers instead of applying to the official representative of a foreign and competing manufacturing country for assistance.

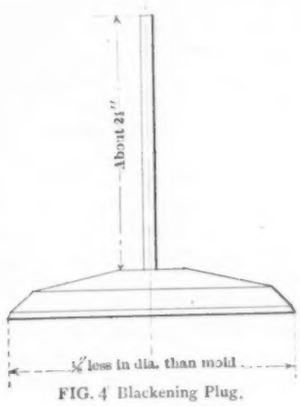


FIG. 4 Blackening Plug.

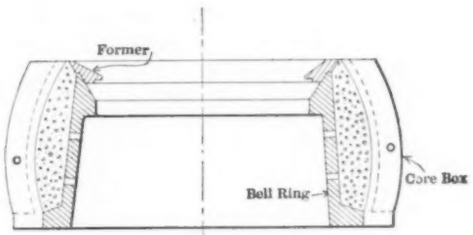


FIG. 5 Section through Joint of Core Box for Bell End Core.

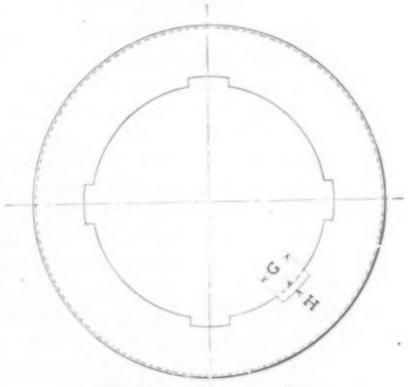


FIG. 6 Plan of Covering Core.

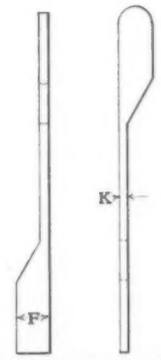


FIG. 7 Gauge for centering Main Core.

WHAT MAY WE EXPECT WHEN AMERICAN HOME TRADE DECLINES?

Passing from this paragraph of the report, the writer ponders over the problem of what will happen when the present era of prosperity of American home trade dies away. The most striking feature in the enormous home trade is the fact that the value of manufactured articles exported has increased to such a large extent. If America's foreign trade in manufactures can increase so much at a time when her home trade is all aglow with prosperity, what will happen when the home trade slackens, and when the manufacturers who have so greatly enlarged and extended their works to meet the extra demand for their products are obliged to look for extended markets outside the United States in order to keep their mills and factories fully employed? When it is remembered that it is only by keeping their works running to their fullest extent and thus keeping down expenses to the lowest point that renders it possible for the majority of the American manufacturers to compete in foreign markets, one can realize how essential it is that they should find neutral markets, where their surplus products can be disposed of so as to avoid an accumulation of stocks.

Those are the thoughts suggested by a shrewd observer residing in the midst of American industry. At the same time he admits that there are at present no signs of this great activity decreasing, but on the contrary there is every indication that the present year will prove quite as prosperous as its predecessor or more so.

IN PACKING FOR SHIPMENT, THE BUYER SHOULD BE CONSIDERED

Many export orders of machinery would be much more satisfactorily executed if the exporter took the buyer more into his confidence so far as regards packing requirements are concerned. It is worse than useless shipping very heavy packages in bulk where the necessary means of transit do not exist at the port of disembarkation, or at some later stage of the journey. It is a golden rule to remember that the weight of packages should coincide with the buyer's requests. Sometimes a strong heavy package is best, but in cases where the machinery must be taken over rough roads and light bridges it must necessarily be split up into a variety of packages even at the risk of their not arriving all simultaneously. It is best to inclose spares of the less expensive small parts, such as bolts and nuts, keys, cotters, and other fittings, the losing or breaking of which is not particularly likely, but would, in the case of an oil engine up country very possibly mean a cessation of running until a new one could be obtained. The exporter should regard the matter from the buyer's standpoint, the buyer indicating to him in what way local circumstances differ from the normal. All plated parts of delicate instruments should be well protected from dampness by judicious greasing, while the insulations on dynamo coils, etc., are best protected by shellac varnish. It has been well suggested that a special class of machinery should be designed suited to the conditions met with in climates presenting extremes of heat and moisture.

THE STANDARDIZATION OF PARTS

There is, too, another important feature connected with the export of machinery and referred to lately by W. P. Digby in his paper on this matter. There is, he says, a necessity for standardizing, not only each type and set, but each separate part, so that a cabled code word will be all that is necessary to insure the despatch of exactly the right size of field coil or piston rod, etc. Every consideration points to complete and comprehensive standardization as the most practical method of overcoming the disabilities of producing in one country articles especially suitable for use in a totally different one. The gradual elimination of awkward projections, or castings calculated to set up strains in cooling, and thus liable to break under slight concussion, has now been going on for some time in the leading ironworks of the United Kingdom, and it should be possible for them each to arrive at their own especial set of sections, not on the basis of differing from competitors, but honestly endeavoring to improve on their design. There is, too, no reason why standardization should destroy that competition which is one of the best incentives to high-class production. The result of its universal adoption would be to cheapen production to an enormous extent, and consequently leave the manufacturer more chance of excelling by the quality and finish of his work, rather than by a claimed higher output or longer life,

difficult to justify in the face of constant changes in the machinery of production, and in the continued evolution of improved types. F. C. C.

England.

Equipment of the Washington, Baltimore & Annapolis Railroad for Single-phase Electric Traction

The development and construction of single-phase alternating-current equipment for electric traction is not confined to one particular company, as evidenced by the large contract recently placed for the entire electric equipment of the Washington, Baltimore & Annapolis Railway with a different concern from that which is equipping the New York, New Haven & Hartford Railroad. But for delays in the financing of the first named road, it would by now be operating on single-phase, as the original promoters of the line were the first to adopt this system.

Some three years ago contracts were let for the construction of this line, but owing to financial difficulties the road was never built. It will be interesting to compare the electrical equipment proposed at that time with the present equipment as an illustration of the progress which is being made in this branch of engineering.

In the former plans for single-phase equipment between Baltimore and Washington it was proposed to use a trolley potential of 1000 volts, current being delivered at this voltage at a frequency of 16 2/3 cycles per second. The present contract calls for a trolley potential of 6600 volts at a frequency of 25 cycles per second. On the cars a four-motor equipment was proposed, each motor having a capacity of 100 horse-power. The new car equipments will consist of quadruple GEA-603 motor equipments for direct or alternating currents, each motor having a capacity of 125 horse-power. While the first proposed motor equipments would have driven the cars at about 40 miles per hour, the new equipments, totaling 500 horse-power, will enable express trains on the road to attain a speed on tangent level track of 60 miles per hour.

The details of the new road have been carefully worked out by the Roberts & Abbot Engineering Company, of Cleveland, Ohio. Single-phase equipment was chosen only after the most careful engineering study had made it apparent that this system would prove most economical and best adapted to meet the special service conditions existing on this road.

THE ROAD AND THE ROLLING-STOCK

Some 60 miles of road will be operated by the new company. The main line will be constructed between Baltimore and Washington, with a branch line, from a point on the main line near Odenton, extending to Annapolis. This station on the new line will be known as Academy Junction. Over the main line between Baltimore and Washington an express and local service will be established, express cars being operated under a 15-minute headway and making the run in 72 minutes. The roadbed will be double-tracked throughout, with sidings arranged at suitable intervals so that the locals may be side-tracked to enable the expresses to maintain schedules. The rolling-stock equipment is to be very complete. Nineteen express cars, capable of making 60 miles per hour on a tangent level track, will be operated. In addition two work-cars will be equipped, each sufficiently powerful to haul a train of five ordinary passenger coaches at 45 miles per hour, while four lower-powered cars will be used for local service. These last mentioned cars will run at a speed of 45 miles per hour. The express and work-cars will each be equipped with four GEA-603 (125 horse-power each) A.C.-D.C. motor equipments with the Sprague-General Electric type "M" train control. The local cars will be similarly controlled but will be driven by two instead of four GEA-603 motors.

THE POWER TRANSMISSION AND DISTRIBUTION

Power for the new road will be purchased from the Potomac Electric Company, of Washington, D. C., and will be delivered by that company at 6600 volts three-phase to a transformer sub-station located about three miles from Chesapeake Junction. In order to obtain a balanced load on the three-phase generators, the current as received at the sub-station will be changed from three-phase to two-phase by groups of two transformers connected three-phase on the 6600-volt primary side and two-phase on the secondary side. Half of the transformers will have the secondaries wound for 6600 volts and the other half for 33,000 volts. The 6600-volt windings will all be connected in parallel on the same phase, supplying single-phase current to the trolley as far as Academy Junction. The 33,000-volt secondary windings will all be connected in multiple on the second phase, to the 33,000-volt transmission line, which will supply current to a step-down sub-station located at Academy Junction. The Chesapeake Junction sub-station will contain seven 800-kilowatt water-cooled transformers, three with 33,000-volt secondaries and four with 6600-volt secondaries, one of the latter transformers forming a reserve.

At Academy Junction there will be four water-cooled transformers, 25 cycles, 800 kilowatts, reducing the single-phase 33,000-volt current of the transmission line to 6600-volt current suitable for delivery to the cars. These transformers will supply the Baltimore and the Annapolis sections of the line.

The sub-station at Academy Junction will be located adjacent to the car barns. For greater safety in inspecting and handling the cars, all of the trolley circuits in the car barn will be arranged for 600-volt direct current, and for this purpose two 300-kilowatt motor-generator sets will be installed in the transformer sub-station, changing the 6600-volt alternating current to 600 volts direct current. The motor end of these motor-generator sets will be connected direct to the trolley circuits, one phase being led from the trolley coming from Chesapeake Junction and the other from the Academy Junction transformers. A feeder regulator will be placed in one phase so that the motor-generator sets will act as balancers, permitting the Academy Junction transformers connected on phase "B" to feed into the trolley line supplied by the Chesapeake Junction transformers on phase "A." In addition to acting as balancers and to supplying current to the cars in the barns, the motor-generator sets will also supply direct current to the motors in the repair shops located at this point.

Government regulations within the District of Columbia prohibit the use of the track return, so that within this section the cars will be operated with a double trolley. This portion of the tracks, as well as that within the city of Baltimore, is at present operated by direct current, and the new cars are designed to operate on direct current over these sections of the line.

IMPROVEMENT OF THE PERMANENT WAY

The present Washington, Baltimore & Annapolis Railway Company which is constructing the line is quite distinct from the initial corporation. The new company, under the head of its president, Geo C. Bishop, has considerably broadened the former plans. Land has been purchased for a wider right-of-way along the route, and new bridges are being built so that the roadbed will be excellent. The engineering work is in charge of the Roberts & Abbot Engineering Company, of Cleveland, Ohio, and contracts have been placed with the General Electric Company for the complete electrical equipment. The construction and operation of this road will be watched with great interest, as it is one of the largest and most important installations of the single-phase railway system ever undertaken.

The *Electrical World*, whose editor is a member of the committee in charge, and therefore speaks by the book, announces that the Engineering Societies Building will be entirely completed by November 15, within the time and "within the appropriation." A month later the "holding company" will take up its duties and occupants may thereafter move in at convenience. It is expected that about April 15 the formal dedication will take place. At that time the new and adjoining Engineers' Club building will also be ready.

CORRESPONDENCE

Discussing Phases of Machine Design and Construction

"Tempering" Novo Steel with Cyanide"

"Common Sense" (at page 352) seems to infer that I am an "indiscriminate" user of cyanide, to the detriment of my profession. If he could meet one of my toolmakers and ask him what success, if any, he had in tempering Novo steel with cyanide and oil, and could see for himself what the cutters are doing, he might be glad that he did not sign his real name to his article.

"Common Sense" may be able to attain a satisfactory result by the use of kerosene oil, but after seeing some narrow escapes from cremation in the use of kerosene, I will not use it, nor allow my men to do so.

The master mechanic of our shop thought that a Jessop steel-hardened drill bushing could not be annealed if it were treated with cyanide and allowed to cool off gradually. So I made three shoulder bushings 1 inch long, ½-inch hole and ⅝-inch outside diameter. I heated one in a gas furnace and hardened it as hard as a salt bath could make it; No. 2 I treated in the same way, and of course they both closed in; No. 3 and No. 1 I next put in the furnace and treated with cyanide. After heating I laid No. 1 aside to cool and No. 3 I dipped in a mixture of machine and lard oil. The results were just what we are receiving daily, and though I made this test to satisfy the master mechanic, "Common Sense" can do the same thing, and so can anyone. No. 1 after cooling was soft, No. 2 would not permit the half-inch reamer to enter and required much lapping when pressed into a hole in a jig. No. 3 was just as it was before it went into the fire.

I have never attempted to temper a die larger than 4x5 inches x 1½ inches thick with cyanide, but do not doubt it could be done if the oil bath was large enough. I have in mind a combination drawing and flanging die that I tempered with cyanide over two years ago, and which is still being subjected to a great many tons pressure at every stroke of the press.

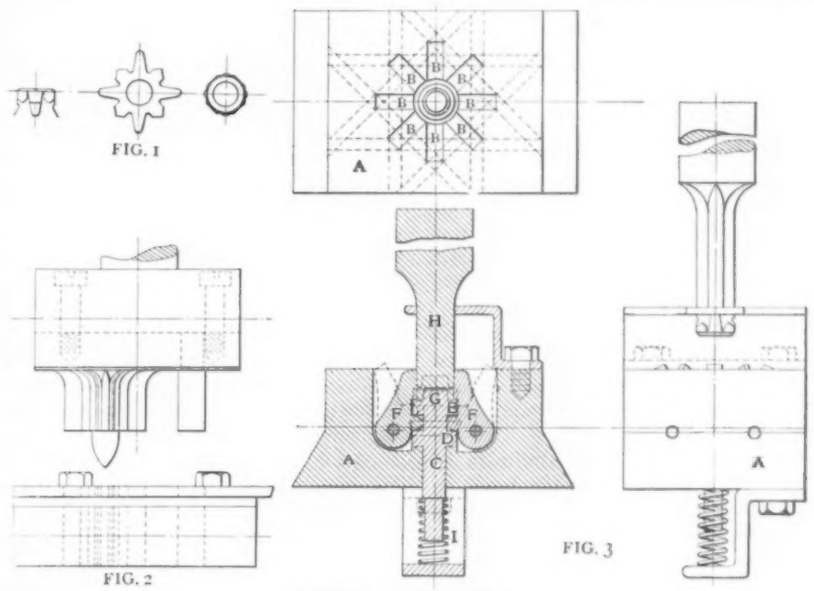
On account of the peculiar shape (one flange being 0.020 inch thicker than the other and the four sides drawn into a rectangular opening, the upsetting and sizing of the flanges taking place just before the bottoming of the punch) it was desirable that the die remain as near as possible to its designed size; this was tempered with cyanide and oil.

I will say that most of our tempering with tool steel is with the salt-water bath, and cyanide we use the most on Novo steel.

CARROLL ASHLEY.

A Blanking Die and Forming Tool for a Clip

The illustrations show a blanking die and forming tool for a small clip. The forming tool is quite different from any I have yet seen in the AMERICAN MACHINIST.



THE WORK AND THE DIES

Fig. 1 shows two views of the clip, one as the blank comes from the blanking die and the other as it is formed up ready for use.

This clip is used on the keyboards of typesetting and casting machines. They are made from half-spring steel and being used in large quantities must be made cheaply.

The punch and die, Fig. 2, is a simple follow die. First the hole is punched, then the stock is moved along. A finished blank and the hole for another are made with the next and subsequent strokes. A boy can punch about 8000 per day.

The former, Fig. 3, consists of a block of steel *A*, with 8 slots or grooves *B* spaced 45 degrees apart in the center. A plunger *C* works through the center of the block with two collars *D E* turned on it about ¼ inch apart. You will see at Fig. 3 that the eight pawls *F* work in the slots and are centered in the block with the tail of each working in the groove in the plunger.

The plunger has a pilot *G* on the top end which fits the hole in the blank. The blank is dropped in a form which sets the wings in their proper place. The punch *H* is just the shape of the finished clip. The punch *H* descends and holds the blank firmly on the plunger *C* and pushes it and the plunger on down into the die. As the plunger is forced down it draws the tails of the pawls *F* down with it. As they are centered at one side, the tops of the pawls are forced in and when the press is at the bottom of its stroke the pawls are forced up tight against the punch. As the press ascends the spring *I* on the bottom of the plunger forces it up, opens the pawls and frees the formed blank which sticks to the punch. A stripper set at the proper hight strips the blank nearly off the punch. When the operator is putting another blank in he gives the formed piece a slight knock which removes it from the punch. It falls in a trough and is carried to a box under the press. A boy can easily form 5000 per day on an ordinary single-acting press. When assembling the pawls in the base *A*, all the pins upon which they are fulcrumed except the last can be driven from the outside. The last pin is dropped in from the top, the block *A* being recessed

for that purpose. A small cap fits on top of the pin and is held in place by two screws. W. H. F.

The Specialist versus the All-around Man

The article of a specialist, at page 515, cannot fail to interest all thinking members of the craft and, after re-reading it several times, it seems to me that the main point at issue has not been touched upon at all, and I wish to add a few words to the discussion.

The "all-around machinist" is disappearing so rapidly, and to such an extent, that some prominent manufacturers of machine tools on being asked what they pay "all-around machinists" answer, "We have none in our employment." From the point of view of the man who thinks he can remain contented through all his active life wearing the uniform and working at machine or bench, specialism offers two inducements—less mental and physical effort, and a higher wage rate with less difficulty in maintaining it.

I do not argue that this contentment is not a good thing—if it is possible—but that where it is possible to one man ninety-nine will never enjoy it.

There is an inborn unrest and discontent in us all which leads to dissatisfaction with our present state and fosters ambition to go farther. The same discontent brought us or our ancestors to this country and is largely responsible for its progress. Being an inherited trait we cannot dispense with it at will.

To the average American boy the end of advancement is the presidency of the country and to the average machinist the progressive steps toward which ambition points are a foremanship, superintendency, managership and ownership.

The essential qualification for such advancement is contained in one word—information. In the first stages it is necessary to be an "all-around machinist" who can carry all the details of operation; later it becomes necessary to have information on numerous subjects which do not pertain to the trade at all, and in the last stages a man to be successful must be an "all-around man" in every way—mechanic, executive, salesman, accountant, correspondent, purchaser, financier, prophet and diplomat.

While skilled specialists receive in this city from 25 to 50 per cent. higher wages than the scale for "all-around machinists," it is evident that they are largely out of the line of ultimate promotion and while they may think they will be content to continue in their present state, the hope of promotion is so remote that their dissatisfaction when it does come finds expression in a pessimistic attitude toward those who followed the other course of training. They find themselves eagerly seconding attacks upon successful men and corporations, grumbling at every success of others, swearing by the anti-capitalistic editorials published daily in our most disreputable newspapers, and loudly cheering on the efforts of those who, disappointed specialists themselves, are trying to overturn the established order of affairs and in ignorance and blindness seeking an outlet for their ambition through a distribution of the achievements of the "all-around men."

It is well that we all look far toward the future and let it not be said that the reason of failure and discontent is because we did not take every possible opportunity presented. A man must have the same training to found a business of his own as to operate another's.

While I approve of the specialist, I advise him to gain all the information possible and, though all may not succeed, all may try, and before he is aware of it he too may be an "all-around man."

LUCIEN I. YEOMANS.

"Jack and Would Be Master of one Trade" shows at page 515, and with clearness how differently it is possible for two men to look at things and still live. From my point of view I say "poor Jack", content to be a lathe hand, with no ambition further, to work for nothing but the wages it will bring. There are a lot of Jacks all over the country, lots of men who have had ambition, met with some rebuffs and settled back in the traces with no further desire than a little wad at the end of each week and plenty of tobacco to kill the time they are not working.

In the present state of things it is necessary that a large part of the human race should be in this state, or possibly the present state of things comes about because so large a number of men have stagnated. Out of a thousand men perhaps 100 may be leading hands, 15 or 20 foremen, 5 or 6 superintendents and one a manager. The other 875 or so are men whose ambitions have not yet been fulfilled or who have settled back in the traces and refuse to pull more than what they think is their share of the load, which is always a little less than the share which others think they ought to pull.

If every man refused to become discouraged and persistently stuck to his wish to get ahead, our whole shop system would be revolutionized. That one little thing carried through all occupations and carried long enough would stop the trust business up tight. A marked difference between conditions of today and those of thirty or forty years ago is in the attitude of men toward their work. Today too many men do just as Jack does, work for the money only. They are content just so long as their pay is fair, no matter what the trust may be doing to those further down the social scale. Years ago it was just these men, whom the trusts of today look out to keep passably contented, who were the manufacturers. If the later generation of men had not been content to dwarf their ambitions the trusts would have been imposibilities. Mere aggregation of money does not make a huge business possible; the predominance of one mind over others does.

I agree with Jack that we ought not to stay in one place less than a year. Three would be better. If a man will take Jack's suggestion and read and study, he can stay in one place a long while without harm, but even then, and for a man who works only for money, there are advantages in leaving the old shop for a time, with the idea of coming back later. Oftentimes there is no more effective way of demonstrating your worth than to step out and let your employer see how large a hole you leave. If it costs him more money to fill it than he paid you, you may rest assured that he will be ready to find a place for you somewhere if you want to get back. And even if you are away only a year, if you are awake, you cannot help getting some ideas that will be worth something to him when you do go back.

Oftentimes, too, the reason the foreman turns down the applicant for a job who calls himself an all-around man is not because he does not want an all-around man, but because he does not believe the man's representations. There are a good number of men who can do any job anywhere, but they are not running around looking for jobs, even when business is pretty poor. The jobs are looking for them, and looking hard too.

After all what is the use of saying anything? Jack is satisfied, he gets his pay, twice as much as someone else gave him. To be sure it is only half as much as someone else would give him if he made himself worth it, but it seems to be all that he wants. But what bothers me is that he represents a class and a large class too. I did not think that any of this class read the AMERICAN MACHINIST, but it seems Jack does. Perhaps, though, he really would like a job that paid twice as well; perhaps he is looking for it on a lathe. I have seen plenty of lathe hands made foremen but they were not specialists.

Perhaps Jack is not really a specialist after all; he has run a lathe, I don't recall how many years, but he has read the technical papers. He admits having worked on general work for a year. Wouldn't he allow himself to be coaxed into taking charge of some work in the shop, provided, of course, there was more pay to be had? Since we know that he does not work for anything but the money, we know that he won't make a very good foreman, but wouldn't he take the chance if he could get it? And wouldn't he be glad he had had that year's experience? Would he hesitate about taking charge of a shop where there were planer jobs and drill-press jobs and milling-machine jobs? I do not believe he would.

CON WISE.

Punches and Dies for Pole Pieces

The press tools described and illustrated in this article are, in some respects, considerably different from the usual type. Some time ago I had to get out a line of similar tools under circumstances which made it necessary to save every cent possible.

To many toolmakers the tools illus-

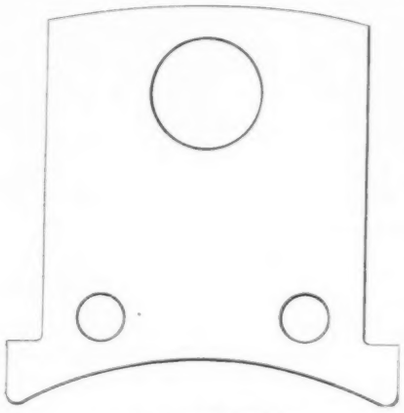


FIG. 1. THE PRODUCT

trated may appear to be unduly light in construction, but several sets built on these lines gave every satisfaction, while their light weight materially lessened the cost of handling and setting.

Fig. 1 shows the pole piece produced by the tools at one stroke. The stock was usually about 1/16 inch thick and rather hard.

Fig. 2 shows the tool in plan while Fig. 3 shows it in section.

In the latter figure the various parts are shown all in one plane for the sake of clearness. The body *A* is of good close grained cast iron, planed on both sides, drilled to templet at *B B B B* and tapped to take the four screws which secure it to the ram of the press. The blanking die is built up of four pieces *C C C C* of best tool steel, hardened and ground to a fit at the joints. Each piece is secured from the back by two flat-head screws *D D* with a steady pin *E* between. The top of the die is machined to leave a narrow grinding strip all around the cutting edges. As, in this type of tool the stamping is always thrown up, it is essential that the vertical faces of the die should be left quite parallel. The holding-down screws and steady pins are reinforced by the copper wedges *F* which are driven in between the die *C* and the pins *G*, each of which has a flat machined on one side down to where it enters the casting *A*. Odd pieces of commutator segment strip make excellent wedges for this purpose. At this stage the punch *H* should be worked through the die and the holes for the small punches and dies bored at one operation, in order to secure perfect alinement.

The circular punches *I I I* are cut from tool steel bar, and after hardening should be drawn to the same color as the blank-die, i.e., a medium straw. It was found that no provision need be made for holding these punches beyond making the shanks good driving fits. Each punch should rest on a thin copper washer, and should also have its face recessed, as shown at Fig. 3.

The ejector *K* is cut from a piece of ⅜-inch boiler plate and should be an easy sliding fit inside the die and over the circular punches. The countersunk holes for the adjusting screws *L* are drilled right through to the back of *A*. Near the edge of each hole, where it comes out at the back, a small hole is drilled and then plugged to keep the drill from running out while drilling the hole for the round nut *M*. When the plug is removed, what remains of the hole serves as a guide for the small pin *N* which is tapped into *M*. In working, the ejector should be set about 1/32 inch above the cutting edges.

Fig. 4 shows the bottom tool in plan while Fig. 5 shows it in section one half only of the large circular die being shown. The blanking punch *H* is machined from a slab of double shear steel and left soft. It is secured to the casting *Q* by four screws *B* and two steady pins *Q*. The face is recessed, leaving a narrow strip all around the cutting edges. The hardened circular dies *R* should be made a driving fit into the body of the punch. The stripper *S* and its adjustment are on exactly the same lines as the ejector for the top tool. The plungers *T* act as guides and stops for the strip from which the stampings are punched. The enlarged head rests on a pad of soft rubber *U* which should be thick enough to allow the pin *T* to project about ⅛ inch through the stripper, which should be set about 1/16 inch above the cutting edges.

Scotland. PERSEVERE.

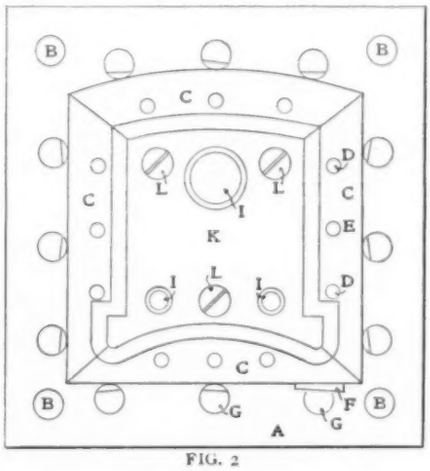


FIG. 2

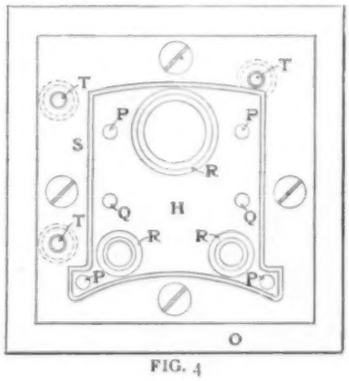


FIG. 4

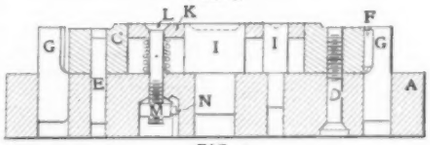


FIG. 3

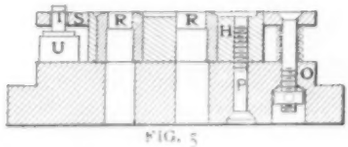


FIG. 5

PRESS TOOLS FOR MAKING POLE PIECES

Checking Drawings

I note in one of the articles that have recently appeared regarding checking drawings that the author states that some checkers will not find too many errors for fear of incurring the displeasure of the draftsman.

It would seem as if this writer was not very familiar with large drawing rooms where checkers are regularly employed; for, so far from losing their positions through detecting too many errors, I believe they are held strictly to account for any spoiled work that may result from their failure to detect errors.

While we would all like to turn out perfect work it is nevertheless a fact that all men are liable to make errors once in a while and any man who goes carefully over the dimensions of a drawing that he has just finished tracing is almost sure to find one or more errors in the figures. All dimensions should be carefully checked by someone and a man is much more likely to detect the errors on another man's work than he is on his own; therefore, I believe it to be the safer plan to have another man do the checking.

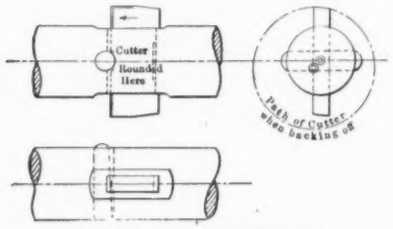
Another question that I should like to see discussed is: What is the best method of impressing on a draftsman the fact that he has made a mistake in such a way that he will be more careful in the future? The usual way seems to be to use violent language, limited only by the extent of the vocabulary at the command of "the boss," giving him to understand that he has held up the whole work in the shop and that a man like him is enough to put the concern out of business. Such talk may relieve the boss's mind, but it seems to me that it leaves a bad impression on the mind of the draftsman long after the boss has forgotten all about it, for no man makes

a mistake for the fun of it and most men will cheerfully do all in their power to set things right.

I have no solution to offer to this question, but hope that some of your contributors may be able to give us some new ideas on the subject. W. ALTON.

Boring Bars and Cutters

I have followed closely the discussion on "Boring Bars and Cutters," and have hoped to see illustrated an old, but never-



BORING BARS AND CUTTERS

theless very efficient and cheap system of boring cutters. As the contributors have not shown it, I take the opportunity of doing so. By way of showing the good points of this system, I will draw attention to others that have been recently shown, and point out where, to me, they are wanting. The cutter shown at page 246 necessitates two slots, expensive (especially so in the slot for the wedge); it also has one piece too many, namely, the pin in the cutter.

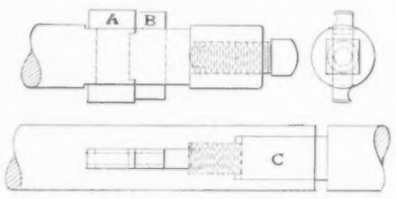
At page 314 the system is mentioned as for accurate work. No doubt good results will be obtained with this cutter, but it is very expensive to make. This certainly debars it from general shop use. At page 351 the system shown has one piece too many, namely, the gib *A*. The wedge *B* is likely to spring the bar, unless made to fit accurately between *A* and *C*, which would make it costly, necessitating all cutters to be exact duplicates in taper. Further, the projections on the cutter are at the cutting end, a point which I think is bad.

The system at page 417 is nearer the general shop line, failing only in having no centering qualities. The wedge also requires too much fitting. W. S. Leonard's remarks about backing off the cutter are very good, and I will explain how we have, for many years, done this backing off on our cutters. From the illustration here given, the system which I set out to show can be understood without any special explanation. Its good points are cheapness; absence of any elaboration; the cutter being properly supported against the cut; the centering projections doing nothing else but center; the wedge being made of round-drill rod requires nothing more than a taper flat filed its full length; no special taper fitting is required, as the cutter is rounded just where the wedge crosses it; also the tendency to spring the bar out of truth is minimized. Its efficiency and cheapness make it suitable for general use, where all the users are not toolmakers.

The end view in the illustration shows how we obtain the clearance. We have arbors the same diameter as our boring bars, slotted in the same manner. These arbors have two sets of center holes, one set concentric, and one set eccentric, as shown. We first grind the cutters on the concentric centers, bringing them to correct diameter, then change over to the eccentric centers, and back off to the edge, as one would back off a reamer. The cutter is reversed in the arbor, and the other end is backed off. We are thus sure of equal backing off for both ends. The universal grinding machine will do this backing off quicker and better than one can do it by hand.

England. CHAS H. CATON.

The illustrations show boring bars which I have used successfully. In my experience of boring bars and boring, more depends on the form of the cutters than on the bar. In boring, the first hole is as a rule the smoothest, due to the cutter being sharp on the cutting edge. The longer it is used the rougher the bore. To avoid this, or to reduce it to a minimum, I designed this style of cutter for boring some small motor pole pieces, and the result was so successful that I use no other. The bar is fitted with two cutters—the larger one *A*, which sizes the hole, being about 0.015 larger than the first cutter *B*, which does the roughing. The cutting edge should be slightly rounded or chamfered. It will be noted that the bar is machined flat where the cutter slot is, so that the finishing cutter can be fitted to it. The cutter *A* has a gap cut in it for the roughing cutter *B* to fit. A small shoe is put in for the screw to abut against, as it prevents the screw from drawing the cutter one way or the other when tightening. For long bars I have the ends fitted as at *C* by boring the end of the bar that carries the cutter and, fitting the exten-



BORING BARS AND CUTTERS

sion, it will keep the bar true. A hole can be put in for tightening with a tommy. The roughing cutter should always be ground on the cutting face and can be renewed, as the finishing one will outlast a dozen of the roughing cutters.

London, England. C. PETITJEAN.

In answer to Draftsman's article on boring bars at page 351, if there were many slots of the same widths to be made I would do the job in this way: Drill one end hole the size of the width of the slot. Then take it to a slotter and square that hole by broaching. The illustration gives only one broach *A*, but it would take at least three of them. This broach would be driven by the combined broach and slotter bar *B*. I would operate it by moving the slotter ram by the vertical-adjustment screw. The broach part of *B* serves to make the slot long enough for a reasonably stiff slotter bar to pass through. The slotter bar in this case is the upper

THE SLOTTER BAR AND BROACH

end of *B*, holding the inserted tool *C*, which is to finish the job.

This broach is given too much taper in the illustration. I would give it about 1/32 inch taper and make several strokes, using shims 1/32 inch thick, or differing 1/32 inch in thickness to back the broach up. J. SCHURING.

Curing a Hot Bearing

Some few years ago a new vertical milling machine was installed in the works where I was employed, and after running for a little time, gave considerable trouble through the bearing for the cone-shaft heating. This shaft was near the base of the machine, one end being carried in a bushed hole in the column, and the other end by a loose bracket secured to the base. Ordinarily I should think the best way of curing the trouble would be to remove the shaft and scrape the bearing to a better fit; but at this time we had an "Advisory Superintendent," an American with many years' machine-shop experience in the United States, who had come over to put our works straight, and he did it another way. He had the shaft removed, and for the length of the bearing where the trouble was, the shaft was carefully *draw-filed* all round, in a direction parallel with the axis, a dead-smooth file being used for the purpose.

I cannot now remember his theory for doing this, but it certainly cured the trouble. My idea is that after the shaft was put back it would act something like a revolving file, and wear a bearing for itself, and keep on wearing in the same manner for some time, ultimately spoiling the bush; but I was not long enough in that works to watch it through an extended trial, and have not heard what the bearing is like now. What I would like to know is if any other of your correspondents have had a similar experience, and if it is considered good practice in America to do this. A. MILLER.

M——, England.

Back Numbers of American Machinist—Development of Machine Tools and Machinists' Kits—Interchange of Ideas

Some time ago I attended a sale of household goods and among other things I bought about five hundred pounds of back volumes of the AMERICAN MACHINIST. Inasmuch as I have been subject to unfavorable criticism from different members of my family because of the number of mechanical journals in the house, the arrival of the new batch did not tend to alleviate matters. Fortunately, it was met with a spirit of resignation which plainly said that my case was hopeless and that no amount of protest would cause me to see the uselessness in the accumulation of material which I "could not read in twenty years." Incidentally I was adjudged unaccountably foolish, because I had not purchased a like number of standard magazines abounding with all grades of fiction, etc. But for myself what a feast there is in that lot of AMERICAN MACHINISTS! I believe that the purchase of those papers will be the best investment which I have ever made. In my spare moments I am simply living among that pile and those old ideas given years ago are just as practical and interesting and appeal to one with the same logic as those which come out in the present issues. Ideas which in those days, as I infer from the tone of the articles and their subsequent criticism, were considered the dreams of an idealist and dubbed as romantic, are in constant use today and many of them are considered indispensable. Our improved conditions and further advancement in the natural course of evolution have made them wholly practical. I also see many ideas shown in these old papers which some of us no doubt think are recent developments in machine design, while in reality they are schemes originated long ago, unsuited for the times in which they were written, but fitting admirably into our present conditions. They were the ideas of men who intellectually were years ahead of their time and by reason of the unreadiness of the mechanical world to receive them, no doubt they derived no direct benefit from their ingenuity.

I find most interesting the complete record of the development of different machine tools which is readily followed in both the reading and advertising columns. The names of what are now considered the best known makes in the machine tool line appear almost from the first issues. But how simple and crude are the machines when compared with those of the present time which still bear the same name. Yet they were then lauded as the acme of perfection, and, relatively considered no doubt the claim was correct. It is easy to follow the development of any of these machines and one can almost imagine the faults and difficulties together with generally changing conditions which made each improvement essential. Often one can read between the lines and, by considering how one thing may have led to another, see the schemes which were most likely advanced before a contemplated change of design was adopted. In going over the evolution of machine design generally the progress seems much more rapid in later years than formerly. For instance a comparison of the standard machines of 1880 to 1890 shows more general likeness in both appearance and function than those of 1890 to 1900, and the changes in the last six years are still greater and more radical than those in the ten years of the '90s. Apparently each succeeding year covers a wider lap than the one preceding it. The progress is more in geometrical than arithmetical progression. This being true what wonderful developments are in store for us in the future, for surely acceleration of our progress will not wane.

And the small tools, those which we find in every up-to-date machinist's tool box, all of which he feels are absolutely essential in his work, not many years ago were rare luxuries to be found only in the office of the foreman and superintendent, often kept strictly under lock and key. Because they are now so common, it seems strange to read a description of them as something new and superior. Yet we know in the present small tools radical changes and improvements are constantly taking place, or entirely new tools appear, which wholly replace them. It is probable that in somewhat the same manner as we now view the small-tool kit of 20 years ago, the workman of 20 years hence will look upon our present up-to-date kits. A journal like the AMERICAN MACHINIST makes of us one great mechanical family exchanging opinions and ideas which lead to the advancement of the line on which we are working. Individual effort shows its value in its results only by its readiness to grasp the ideas set forth, and a willingness to put them to practical use. If through any of the ideas received, some new thought is suggested, it is clearly one's duty to impart it to others. It is interesting to note in these old issues the number of familiar names, some of them of men who are still contributors, and many that appear on well known products. It is pleasant to think that some day improvements of which now we dare not even dream, will be common, and we will look back on the present day and all of our boasted improvements with a reverential pity somewhat akin to that of the old fellows who remember the advent of the twist drill or the wonderful new lathe with a lead screw. I have that degree of confidence in our ever increasing growth, in bettered conditions which eventually will make our advancement yet more rapid, that the thought of it causes me to decidedly belie my signature.

PESSIMIST.

"A Farm-engine Repair"—Other Unusual Things

The letter by W. D. Graves, at page 355, on a farm-engine repair recalled to my memory some unusual things that I have seen on farm engines, these being used for ginning and sawmill work. A man came into the shop for a crank-pin brass and, when asked what that black thing in the strap was, replied, "a pine knot." He also said that he had sawed 30,000 feet of timber, using that pine knot for brasses.

I knew an engineer who used hardwood quarter boxes in a Corliss engine, and the experiment cost the company $300. Haphazard makeshifts are costly, usually. I went out to the country to put in some boiler tubes, and when I had finished the tube job the man asked me to look at his engine valve. He said that he thought he had it about right, but as it took so much wood to keep steam up, possibly he had missed it a fraction. And so he had. He had the valve set to take steam at half stroke; you can imagine the result.

Another instance: A man came in for a set of cylinder rings; the old ones were of spring steel forged to shape, and judging by the polished surface he did a No. 1 job.

We make a few brasses and crank pins, with no sizes to work to except the scraps brought for a sample; and we always try to make the hole in the brasses large enough and the pin the same size. We get jacked up sometimes, but we know our man next time. Here is a sample of the people who jack us up: Mr. Smith brings in a broken valve stem; we make him a new one. He is back next day for another one, and says our iron is N.G. He is in the shop after the third one before I talk up to him. Mr. Smith's valve seat is a nice curve, and he has been jamming the nuts against the valve.

Another man's boiler has no gage that is good for anything, but it has a leak under the flange on the dome, and he gages his water by utilizing the leak for a gage cock. I told this fellow that boilers rigged out like this were good fool-killers.

JAS. STANLEY.

A Geometrical Problem

The following is offered as a solution of the problem at page 189, in which the arm PT, Fig. 1, is to be made to swing to position PS through angle α, around P as the pivot, the motion to be had through a connecting rod joined to PT and getting its motion from A and B as the extreme points on the line of travel

of the outer end of the connecting rod, the length of the connecting rod and the position on $P\,T$ where it must be joined being required.

These may not be predetermined. With the connecting rod as one side, the arm as another and a line drawn from P through the outer end of the connecting rod, we have a series of triangles, $A\,S\,P$, $B\,T\,P$, which vary at every point of the stroke. As the connecting rod makes one side and the arm another, we have a series of triangles having two sides common and whose third side varies according to the distance from P to the outer end of the rod.

With the relation of A and B to P given with respect to the base and altitude, as it must be, to form the problem, we have the length of the third side in the two extreme triangles, which we will use in the solution.

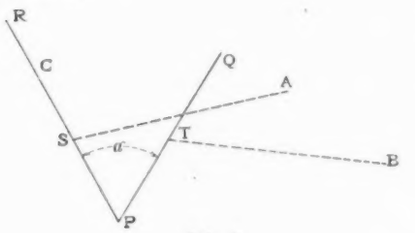


FIG. 1

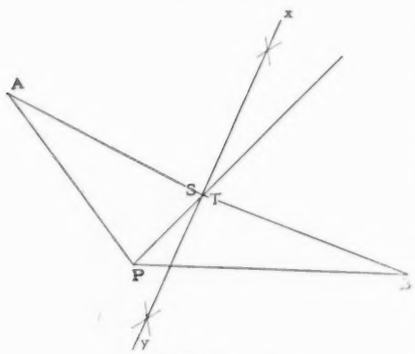


FIG. 2

A GEOMETRICAL PROBLEM

As points A and B are in a given relation to P, and as angle a is known in a given position, the angle $B\,P\,T$ may be computed or laid off from a diagram, and in the same way angle $A\,P\,S$. $B\,P\,T$ is the angle adjacent to the known side $B\,P$ and $A\,P\,S$ the angle adjacent to the known side $A\,P$.

We have now to construct two triangles with a side of each and one adjacent angle known, the other two sides to be equal respectively to each other. To do this we will lay off the angle $B\,P\,T$ and hold length of side $B\,P$; lay off also angle $A\,P\,S$, holding the length of side $A\,P$. In laying off angle $A\,P\,S$, place side $P\,S$ coincident with side $P\,T$ of angle $B\,P\,T$, as in Fig. 2.

It is evident from this figure that if a line $x\,y$ be drawn perpendicular to and midway between points A and B, any point on that line would be equidistant from A and B; therefore the connecting-rod side, or the side opposite the known angle, must be from points A and B to some point on line $x\,y$. As the connecting rod must also be equidistant from A and B to some point on $P\,T$—$P\,S$, and as $x\,y$ cuts $P\,T$—$P\,S$ at T-S, then T-S is the only point equidistant from A and B and from P which will give to one triangle the side $P\,B$ with its adjacent angle $S\,P\,B$, and to the other triangle the side $A\,P$ with its adjacent angle $A\,P\,T$.

To prove this it will only be necessary to lay off any point on the line $x\,y$ other than T-S, which will be found to vary the angles $A\,P\,T$ and $B\,P\,S$, which is contrary to the problem. Or lay off any point not on $x\,y$, which will be found to vary $A\,P\,T$ and $B\,P\,S$ and also to be unequally distant from A and B. As T-S is the only point which meets the requirements of the problem, it must be the point which completes our triangles and gives us $P\,T$—$P\,S$ as the arm length and $A\,T$ and $S\,B$ as the connecting-rod length.

This solution will be found applicable to any variation of the problem.

CHAS. A. KELLEY.

Technical English as Viewed by the Non-technical Man

The other day a man brought an anglicized German catalog into the shop. By *anglicized* I mean a direct translation by a German of a German catalog.

The translator evidently did not know a single English technical term and had relied on his German-English dictionary to help him out.

The description of the machine was very funny.

"The bed of this machine is supported on *scantlings*." The cut of the machine showed the bed supported on *columns*.

I, like the devil in the Book of Job, have also been a wanderer "to and fro and up and down in the earth" (my wife says I resemble in many other ways the gentleman referred to) and have picked up a smattering of several modern languages. So I took a German dictionary and turned to the word *Ständer* which I always thought meant column. To my surprise I found it means: *Water tub, pillar, scantling, post, fish box*. So it's just chance that the machine bed was not supported on *fish boxes* or *water tubs*. Of course the really enterprising translator could have done better. There were six columns to the machine; he could have supported two of the corners on a *water tub* and a *pillar*, the other two corners on a *post* and a *fish-box* and the two center supports could have been *scantlings*.

All the shafts (*Stange*) in the machine were referred to as *sticks*, and so on. While going over this catalog it occurred to me that mechanical English is a foreign language to the average layman. So I decided to take a simple sentence in mechanical English and translate it with the aid of a dictionary of synonyms into synonymous English. In that way we may see how the foreigner gets into trouble and extend to him our sympathy.

For my example I take the second part of the title of the article at page 543 which is, "Comparative friction of punches with and without clearance." Taking Soule's dictionary of synonyms, I find I can distort this sentence into: "Able to compare confrication of borers accompanying and in the absence of exoneration."

The foreigner who relies upon his dictionary to help him is often led by it to say very amusing things.

Many years ago my grandfather was a merchant in Glasgow. He had a country house at Arrochar in the west highlands. It was his custom to invite foreigners, with whom he did business, to stay a few days at Arrochar when they came to Scotland.

My mother told me the following story about a Frenchman who had been staying with them for a week. He had prepared a pretty little speech to make to my grandmother on parting.

The carriage was at the door, Monsieur turned to my grandmother and said: "Madame Smiss, I sank you for ze bon reception I have receive' at your hand. My knowledge of ze English language is not so zat I can to you express my sentiments, but permit me my dear madame (placing his hand on his heart) to assure you zat my heart *smells*."

He had evidently looked in his dictionary and found that *sentir* means to *smell* or to *feel*, and had of course chosen the wrong word, just as you or I would have done.

An Englishman once had the following French sentence to translate: *L'anglais avait du sang froid*. (The Englishman had presence of mind.) He dug out of his dictionary *L'anglais* the Englishman; *avait* had; *du* of the; *sang* blood; *froid* cold; which when collated by him read, "The Englishman had a bloody cold." *Hors de combat* was once translated by a school boy as "war horse."

The title of Sheridan's play "Love's last shift" was translated into French by a Frenchman; *"La dernière chemise de l'amour,"* i.e., "The last shirt of love."

There is, however, one thing to be said in favor of the foreigner. No matter how one may murder his language he never laughs. I know because I am a linguicide myself.

DIXIE.

Efficiency of Screws

It may be taken for granted that the most useful detail in machinery is the screw, which being the case it is highly essential that we thoroughly understand the difference between its apparent mechanical advantage and its actual efficiency.

A paper read some years ago before the American Society of Mechanical Engineers, by Mr. McBride, gave a practical

illustration of the amount of power absorbed by friction in the screw. He measured the force applied by a man on a lever against a given load to be raised, and showed a very surprising loss by friction. In closing his paper Mr. McBride remarked that the text-books were quiet on screw efficiency. Some years before the presentation of this paper, screw efficiency had found a place in Goodeve's "Principles of Mechanics" and this formula was given:

$$P = \frac{W r (\tan \alpha \times \theta)}{\tan \alpha}$$

in which

P = power.
W = weight.
r = radius of screw.
α = pitch angle of screw.
θ = angle of friction.

This may be written:

$$\frac{W r}{P} = \frac{\tan \alpha}{\tan (\alpha + \theta)},$$

of which

$$\frac{\tan \alpha}{\tan (\alpha + \theta)}$$

has been used in calculating the accompanying efficiency table for various pitch angles and coefficients of friction.

For ordinary screw threads with surface contact and no special lubricant, $\tan \theta$ may be 0.1, or greater, as the conditions require. The efficiency of U. S. standard thread screws is approximately 1 per cent. less than the values given in the table.

Pitch Angle.	Tan of Pitch Angle α.	Coefficient Tan θ.				
		.01	.02	.03	.1	.2
1°	.017	.629	.459	.361	.145	.078
3°	.052	.838	.722	.634	.342	.206
5°	.087	.898	.813	.743	.465	.303
7°	.122	.924	.859	.802	.550	.378
8°	.140	.933	.876	.823	.583	.411
9°	.158	.940	.887	.840	.612	.441
10°	.176	.946	.897	.854	.637	.468
11°	.194	.950	.906	.866	.659	.492
13°	.230	.958	.920	.884	.696	.534
15°	.267	.964	.930	.892	.727	.571

SCREW EFFICIENCY TABLE.

Jos. W. Bramwell.

Checking Drawings

As I have had a little drawing-board practice, besides having had charge of a drawing room with a dozen draftsmen in it, and also have had to machine up and assemble castings from drawings by other draftsmen, I have been quite interested in the discussion on checking drawings.

So far as I have seen, the checker seems to be infallible. He finds the mistakes of others, but no one finds his or those that get past him, and so I ask myself: Is he infallible, and is not the standard of the drawing room lowered when the men understand that their work will be revised? Is there not too a tendency once in a while to put up a job on the checker, just an apparent mistake, some of the dimensions beginning and ending nowhere, and seemingly valueless? Are there not sometimes two or more views piled one on top of the other, the broken lines resembling fractions of a Morse alphabet? I have seen as many as four plan views piled one on top of the other, and while it saved drawing paper, and was ingenious in the extreme, it was exasperating and costly. It sometimes happens that the person who has been delegated to do the checking is nervous and irritable, but with authority to make the wrong-doer sit up and take notice; and when such is the case, there is quite apt to be a tempest brewing all the time.

Personally I do not think I would stay in a drawing room and have my work checked up, or, if I did, I would see to it that the checker got scant picking. It seems to me that the time to check a drawing is while it is being executed, and the person in charge of the draftsmen is the best one to scrutinize and correct the work as it is being done; for it seems to me that if the draftsman completes a drawing, and the person who checks it up finds that the different parts will not assemble, owing to the impenetrability of matter to the fact, or that thin air is not a good substance to anchor machine parts to, and that some of the work, perhaps all of it, has to be done over, the checker might better do the job from start to finish.

Quite recently after making a pencil drawing of the side elevation of a new machine, I started in to make some of the cross sections, only to find in one place a very good illustration of the impenetrability of matter, and in another that thin air would not do to transmit motion from one part to another, and it took quite a lot of time to straighten out the tangle. There was no one to fall back on; it was a case of make it go anyway, and it acted as a stimulant to find something that made me sit up and take notice. At the time I had a dozen draftsmen, of whom two or three were not quite passable; that is, they were not able to make good, and had been put on a class of work on which it was well nigh impossible to go wrong. This may be checking the draftsman rather than checking his work. If there are not enough good draftsmen to go around, and such seems to be the case, the shortage will have to be made up by employing some of the poor ones and keeping them on fool-proof work as much as possible. The same thing is done in the shop on the different tools; why not in the drawing room?

Individually I would not like detailing or tracing for a steady diet, but I have seen men who took kindly to both, and would keep at either continuously. They were specialists and contented, and if possible should be left alone. If good (by which I mean correct) work is demanded, and the force is not equal to it, crowd them up to do better work. I believe most men respond quite readily to the demand for better work, and it seems reasonable that they should. Many men do high-grade work because they are incapable of doing the cheap kind, and to make a business of checking the work of good men is to make them feel that they are not to be trusted; and frequently a man who has been made to feel like thirty cents, gets a new job.

I am aware that it is expensive to correct mistakes after the pattern shop has discovered them, still more so to let them pass the pattern shop, and be corrected in the foundry, and still more so to have them corrected in the machine shop; but even at the last place the total cost of checking may be more than the cost of the mistakes made, and the assembled machine may be the best checker. I am satisfied that for a stimulant to an increase of vigilance, one mistake found when assembling is worth a dozen found by the checker. G. Schneider.

Some Information about Journal Bearings

At page 485 E. R. Plaisted complains of the lack of definite information in books about journal bearings, and expresses the hope of drawing out from somebody the desired information. I hope he will not be disappointed.

Competition is not usually credited with causing better work, but in my case it is responsible for some radical changes of opinions and methods regarding surfaces under pressure.

Like the rest of the machinists I was taught to turn, file and polish journals, but being required to turn the shafts of threshing-machine cylinders for which my competitors had fixed a price, I decided to economize and turned the shafts with water and omitted the filing and polishing. The bearings were babbitted to the bare shaft, the thread left by the tool being transferred to the babbitt, no scraping was done.

Various adjectives are used in the shop to describe such a method of doing work, but I heard no complaints from users who always returned when their machines needed repairing. I noticed that one end of the journal always showed signs of having run dry. Making the thread right hand on one side of the center of the bearing and left hand on the other, so that it would work the oil toward the ends of the bearings, corrected that, and produced a cool running bearing.

As the oil groove in the babbitt was always filled when returned for repairs, it was suppressed, a round hole in the center supplying the oil with satisfactory re-

sults. Equally satisfactory results attended the method when applied to wood-working machinery, or in any case where the shaft rotated in one direction. On vertical shafts it worked well where the thread tended to lift the oil.

To further test the method I fitted up a circular saw, the arbor being about 1 inch diameter, the bearings 4 inches long and the pulley between them. The casting was planed on the bottom to make it easier to fit the wooden frame. The bearings were bored in a lathe and the arbor fitted too tight to turn by hand when the caps were down. The caps were slackened a little and the arbor set in motion. The caps were gradually brought down tight. The oiling arrangement was a trough cast on top, fitted with hemp and oiled morning and noon. It ran 2700 revolutions per minute, machine steel against cast iron and never heated or stuck during some 7 or 8 years.

A peculiar case was brought to my notice some time ago: A new machine tool had been installed and being a high-class machine should have run all right. One bearing, however, would heat in spite of all the oil that could be fed to it. The man in charge called me for consultation and the most careful scrutiny failed to detect any fault in the workmanship. Two features in the design did not suit me: one was a straight oil groove cut the entire length of the bearing, which was in one piece; the other a washer having radial grooves bearing against one end of the bearing. I theorized that as the shaft ran at a high speed, that washer made a good centrifugal pump and drained the oil from the groove. About ½ inch of the groove next the washer was filled with waste and the heating stopped.

I read in Kent that car-axle bearings wear forward, contrary to the horizontal direction of pressure, the wear beginning where the lubrication stops. The conclusions I have reached on bearings are: that in the case of rigid bearings they should be short, not over two diameters long; that the area should be sufficient to enable the oil to form a continuous film; that the oil groove commonly cut in the upper side of bearing is seldom any benefit and often is an injury; that where a groove is necessary it should be in the moving part, thus carrying a body of oil where the pressure would otherwise force it out; that the oil should not travel over the same point twice, but move continually from the inlet to the outlet, carrying any dirt with it; that oil should be fed continuously and if possible under pressure.

Trusting that this will have the effect of stirring others to divulge what they know, I will stop and give them a chance.

JAMES BELL.

The Auk Auckland Harbor Board of New Zealand is to spend $10,000,000 to replace old wooden wharves with steel-concrete wharves.

Hours of Labor—Difference between Nominal Hours and Actual Hours—Occupations that may be either Work or Recreation — General Reduction of Hours

BY "ENTROPY"

At page 378 is given an abstract of what a certain learned doctor says about our working hours. I formerly worked some myself, and not so long ago but what this interests me and sets me thinking. I judge that his theory is pretty well met by actual conditions. It looks to me as if men actually worked just about the length of time, in different occupations, that he suggests. They draw pay for longer hours of course. But look out in the shop; see that lathe hand over there sitting on the bench whistling? Do you call that working? He is there ready to stop the lathe just after something smashes and after his cut runs up he will take out his work and put in another piece and start the feed and the whistle again. I suppose you will tell me that the man who is industriously scraping that lathe carriage over there is working steadily from seven till six.

WORK AND WORK

Just try telling him that he can go out chestnutting as soon as he gets it done, and convince him that you will not use his record to make him work faster on the next job. He will get out so quick that you will be scared. It is a good deal analogous to a box full of broken stone. You can put in a lot of sand without increasing the volume and then when it is full of stone and sand you can put in quite a bit of cement and still have your box full and no more.

THE BRAIN WORKER

Then to get outside the shop; we all recognize the man who struts into the office about 10 o'clock with his hands in his pockets and an air of supreme importance and tells us in a resounding bass voice that he works from six o'clock in the morning till twelve at night. "Brain work, too, sir! Done it since I was a boy, sir. Never had a vacation!" Do you believe it all? Perhaps not if you saw him in the baldheaded row at the theater the night before and especially if he had been swapping tall stories with you for an hour. It is easy to think you are working, but there are few men who conscientiously put their whole energy on the work for which they are paid for more hours a day than the physician quoted considers allowable.

SHORTENING OF HOURS

If we only work half or two-thirds of the time anyway, why not concentrate it and have more spare time to ourselves? There are several reasons, among which this one is prominent, and it is, men on the average cannot or will not concentrate their minds on their work enough to push it along at top speed for the sake of getting shorter hours. They think they know better than to do it, too. They feel that if they can get where they can do a day's work in six hours, then if they will not keep on working for four hours more someone else will. The machine-shop proprietor who has paid out good money for his equipment is not going to see that equipment lie idle for any more hours out of the twenty-four than he can help. He knows that to run one shift of men more than ten hours does not pay. He finds this out every time he runs overtime in a rush job. For a few days or nights the men all like it, but after a little while they begin to feel that the extra money is not worth the extra work. If the employer says to himself that he will run two shifts of men, then he is getting into more trouble owing to the difficulty of placing the divided responsibility between the two shifts as to poor work, slow work and injured tools. The more refined, the more expensive his plant, the greater his desire and his need to run it as many hours a day as possible. Also in the case of semi-automatic machinery, the less his need of skilled labor.

PIECE-WORK AND PREMIUM SYSTEMS

The piece-work system and the premium system have both been used to speed up production, but never so far as the writer knows to make things more rational for the worker. The result is that these systems attract to themselves the best and most physically able of the workers. Production is carried along at a rate which would be a physical or mental impossibility to the average man. If every shop should adopt these plans and stick to them without cutting rates we would soon be in just the same state as before. The advantages of these systems are only to the first users of them. The hand worker is kept at work the same length of time as the machine hand mainly from the same inertia that permeates the mechanical world, so he times his efforts to about the same speed as the others.

WORK THAT MAY BE RECREATION

If I should say now that I hope to live to see work done away with almost altogether, I hope no one will judge that I am growing daffy until he has read a line or two more. Some time ago I defined work and recreation in these columns in about these terms: Work consists in doing something that you would not do at all, or would not do at that particular time, if you did not have to. Recreation may consist in doing the same thing at a time when you wish to. If a man is so situated that in order to earn his daily bread he must do something that he does not enjoy, then he is truly working and I pity him. If on the other hand he is engaged in some occupation such that he is glad to get to work in the morning and sorry

when it is quitting time, such that he thinks about it evenings and after he is abed, then he no longer has to work for a living. His is then what I believe to be the normal state. He does not want a vacation. He may need it a great deal more than the man who takes one every time he gets a running job in his lathe, but he does not realize it till the doctors tell him so. What he needs is some hobby to ride which is only less interesting than his regular vocation. If a man can get two rather different things to do between which he can divide his time, then he can be active about one or the other through his whole waking hours and still be in good physical and mental condition.

DOING WORK THAT WE LIKE TO DO

I hope no one will judge from this that I think that everyone ought to knock off his job every time the inclination strikes him. In general every man has a faculty for doing something which is useful, and which is agreeable to him. It may be some job that to the most of us is rather low down on the scale; perhaps it is chopping wood, perhaps it is something else equally significant. That is the job for him to follow up. Perhaps it does not appear to be a good paying job. Don't mind that. It may be that a man who can do a thoroughly good job of chopping kindlings can get a fancy wage. As a general thing, a man who can do a good job at anything can command above market rates. If he can chop kindling artistically, perhaps it may lead from one thing to another, till he is an expert wood carver. Above all things, do not take up with any vocation because someone else made money at it. Your only chance of making money comes of doing something you like to do. If your work seems like drudgery, and you can see no daylight ahead, you are in the wrong pew. Get out and change over. I know it is said to be dangerous to change vocations after one is 30. It is safe, I know, for I have tried it; but be sure you change for something that you definitely believe to be better suited to your ability. Your parents may have spoiled a good minister to make a half-way machinist. I do not want to advertise the correspondence schools, but there are ways in which a man can find out if he can change with a likelihood of success, without burning his bridges behind him.

The amount of work necessary for a man to do to keep himself and his family from starving would really be very little but for the waste, which seems to be a part of our American life. I do not wish to see American working men reduce themselves to a basis of least effort. The art of a nation is an index of its prosperity. It is the instinct of man to surround himself with things beautiful. To learn to make and then to make beautiful things is, or ought to be, part of a man's avocation. Today our workmen of artistic tastes spend their time making things of value, but for whom? Not for themselves; not the people who need them, but for the few rich, who understand them oftentimes only as a sign of their own opulence to others. With the present trend of art toward the simple elegance which expresses the sanest period of the development of the world's tastes, it becomes almost imaginable that some day men may labor five or six hours a day at a trade for which they have a love, and then may spend the rest of their time in the domestic circle, which is so much neglected on this side of the water, reading, studying, and making the things which beautify one's home, for his own use, or for exchange with fellow craftsmen, rather than exclusively for sale to the rich.

SOME EFFECTS OF SPEEDING UP

To get men out of their present-day rut, there is no chance, to my mind, like that of the apprentice school. Students in such a school may be taught to consider their work as a problem of which the simplest solution is the only correct one. Brought up as they may be thus, without contact with that dampening influence which is ever felt in the shops whenever a boy shows signs of speeding up to anywhere near his real capacity, there is the possibility that they may demonstrate that the most economical working day from the shop owners' point of view, even, is less than it is at present. A concrete example may show this. Suppose that I am hiring men for $2.50 per day of 10 hours, and that my running expenses are 100 per cent. of my labor cost, or $2.50 per day. I put my men to turning pulleys, which they do at a rate of 10 per day. Those pulleys cost me then 25 cents each for labor, and 25 cents for running expense; total, 50 cents. Now suppose you come along, and you say that you have made a study of the art of turning pulleys, and that you can turn them in 36 minutes each, or ten in six hours, but that you must have $2.50 per day the same as the old gang, and you positively refuse to work over six hours. I look the thing over and ask you if you can fill my shop with men who can do what you agree to do. You get them and we start off. The labor cost is just the same, $2.50 for 10 pulleys. The output of my shop is the same. We run only 6/10 as long. It must reduce my running expenses somewhat. My taxes and interest money run along just the same, but my cost of power and light and heat are cut. It ought to cut it to say $2 per day per man. Whatever it saves is my profit. If it is 50 cents per day, and there are 50 of you, it is a snug little profit. You have to work only six hours per day. You have four hours to enjoy or profit by in some other way, even if only by staying at home and getting acquainted with your wife and babies. You have just as much money as ever. And the jobs are few and far between that cannot be cut in this proportion. Only if you do this, stick to it that you will take less hours rather than more pay. Doing more work and taking more pay is all right till the rest of the workmen equal your record. Then comes a cut, and you go back to where you began. And no union can help you more than temporarily. It seems under our present social system, as if any body of men, if only united, can do anything they please. I haven't a doubt but that a union of all machinists in the country could put the price of machinist labor at $10 per day—for a short time. But in the natural course of things, unless most of the machinists were prepared to change to some other trade on short notice, there would be a most sudden slump back to the old state of affairs. The same is true of any combination of shop owners. If of sufficient numbers they can put the price of their product where they please, for a while; but if demand falls off, it will be a pretty sagacious management that can hold them together. This may sound visionary, but no one acquainted with the houses of American workingmen can doubt but that the tendency is for them to want money, not for money's sake, but for the good it will really do them; not for show, but for substance.

"A New Perforating Machine"

In the description of this machine at page 568 we named Frederick Hart, of Poughkeepsie, as the inventor. We learn from him, however, that while he perfected it and put it into its present form, it was originally invented by Chas. S. Jonas & Bro., the New York City firm referred to in the article.

The exploits of the modern illustrator continue to amaze us. One of the latest examples is to be found in the advertisement of a new book, the hero of which is a civil engineer. In representing this hero at work the artist has evidently taken as the model for his hero an actual man, and his picture shows such a man. But for the instrument he has evidently depended upon his memory of the general appearance of such instruments instead of taking an instrument as his model. The thing shown in a cross between the modern theodolite and the surveyor's compass such as George Washington used, and it is mounted upon an extremely light and flimsy, jointed camera tripod, the whole thing being ridiculous in the extreme.

As an evidence of the interest taken by machinery men of the South in the simplified spelling of which President Roosevelt has become the most prominent advocate, we are in receipt of a booklet issued by A. M. Lockett & Co., of New Orleans, who are machinery agents and dealers, and which pamphlet contains the list of 300 words as spelled by the reformed method, together with the older method.

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Mine Traps for Small Investors

A timely warning is issued for the benefit of those (usually small) investors who are attracted by the advertisements now so boldly appearing in many of the daily papers soliciting subscriptions to the stocks of mining companies, and holding out promises of great reward to him who has the courage to invest in undeveloped mines, at a very low price. One New York paper which has been publishing such advertisements has been stimulated to make some investigation of these matters. It has taken the advertiser at his word and written to some of the banks in the State from which the advertisement emanates and which advertisement referred to "any banker." Many of these bankers replied that no such companies were known to them, nor did they know of any such people as those whose names were appended to advertisements, letters, etc.

It ought to be needless for us to remind our readers that where a financial proposition can be presented which is really half as attractive as those which are thus advertised, there are plenty of men with abundant means ready to invest in such enterprises, and all that is necessary in any case is to call upon one or at most a few of such men.

It is not at all necessary to pay for newspaper space at $200 to $500 a page in order to sell stock at a genuine bargain. Such advertisements are not expected to attract the money of experienced investors, but are expected to make victims of those whose savings are small, and who can ill afford to lose them. The men who publish such advertisements are not philanthropists. They advertise for the money of small and necessarily uninformed investors simply because they have no business proposition which is at all attractive to larger and better informed capitalists.

"The Colossus of Roads"

From the tone of the general comment upon the latest exploit of Mr. Harriman in ousting Stuyvesant Fish from the presidency of the Illinois Central Railroad, it is evident that the matter is viewed with considerable apprehension in many of the most conservative quarters. It is being pointed out that several of the men associated with Mr. Harriman in this move did not make a very creditable showing in connection with the life insurance investigations in New York, and at the same time there seems to be a general impression that it is a menace to the business and industrial interests of the country that a man with Harriman's record should be in control of the largest railway system in the country.

The *Wall Street Journal*, for instance, in an article entitled "The Colossus of Roads" gives expression to some such views and the final paragraph of its article is as follows: "It may be well to remind Mr. Harriman that the Colossus of Rhodes was destroyed by an earthquake."

Such a warning from such a source must certainly be taken to be peculiarly significant.

New Publications

"Internal Energy." By J. V. V. Booraem. 144 6x9-inch pages with numerous diagrams and tables. The McGraw Publishing Company, New York.

As stated in the introduction the object of this volume is to suggest a simple working hypothesis for the estimation of the amount of chemical energy stored within a body. The method consists of analysis of experimented data and is of interest chiefly to chemists and physicists.

"Record of Recent Construction No. 59, 1906." Baldwin Locomotive Works, Philadelphia, Penn.; 32 pp. 6x9 inches. This pamphlet is printed in English and French, and gives photographic views and dimensions of a number of locomotives for quite a variety of services. The heaviest shown is a 4-6-2 type for the Chicago, Burlington & Quincy Railway Company, total weight 230,940 pounds; total heating surface, 3922 square feet, tubes 21 feet long.

"Turning and Boring Tapers." Second Edition. By Fred H. Colvin. Twenty-five 5½x8-inch pages, with 19 illustrations and several tables. The Derry-Collard Company, New York. Price 25 cents.

This handy little pamphlet, known as No. 1 of a series of practical papers published by the above company, now appears in a second edition, showing the demand existing for practical information on the subject of taper turning and boring. The treatise has been slightly enlarged since the first edition.

"American Stationary Engineering." By W. E. Crane. 285 5½x8-inch pages with 107 illustrations. The Derry-Collard Company, New York, Price, $2.

Of engineer's handy books and catechisms, there is a large number and the information contained in this volume is largely of the class contained in such books although it is rather a collection of notes than a general compendium. The book is decidedly fresh and is obviously written by a man of large experience in erecting and operating steam plants. The information given is excellent and much of it is not to be found in other books intended for engine-room readers.

"Elements of Gas Engine Design." By Sandford A. Moss. 197 3¾x6-inch pages. The D. Van Nostrand Company, New York. Price 50 cents.

This little volume, which is No. 121 of Van Nostrand's Science Series, is entirely in keeping with the general high character of that series. It treats its subject in a fundamental rather than a detailed manner,

although a chapter is included on formulas and constants of design. It discusses the chemistry and physics of gas-engine design, gas-engine gas, liquid fuels, cylinder action, compression, combustion, expansion, methods of governing, details of design and other phases of the subject. Much of it is reproduced from our own and other periodicals.

"Elements of Mechanical Drawing." By A. A. Titsworth. 130 10x7-inch pages with 40 full-page plates. John Wiley & Sons, New York. Price $1.25.

This is an addition to the long list of books on mechanical drawing. It is divided into two parts, the first containing exercises in the use of the instruments and simple problems in projections, intersections, development, isometric projection, shades, shadows and perspective, and the second containing problems in descriptive geometry. The exercises and problems are presented in a clear and logical order, but of course do not differ essentially from those given in other similar books.

F. B. Faulkner, instructor in machine work in the School of Engineering of the Pennsylvania State College, sends us a copy of his instruction book in the course in machine-shop work, which seems very well arranged for the purpose it is intended to serve; namely as a hand book for the student and evidently also as something in the nature of a protection for the equipment of machine tools, frequent warnings being interspersed against practices known to be detrimental to proper maintenance of machine-shop equipment. We are interested to note that in this manual, issued by a prominent educational establishment, modern ideas regarding the spelling of certain words are introduced; and we have "tho" and "thru." The leaven works.

"Metallurgy of Cast Iron." By Thomas D. West. Eleventh edition. 627 5x7¼-inch pages with 153 illustrations. The Cleveland Printing Company, Cleveland, Ohio. Price $3.

The demand for eleven editions of this book in ten years is sufficient evidence that it has filled a want. The author has been a leader in advocating reforms in foundry practice and he does not allow the reader of his prefaces to overlook the fact, the five prefaces to different editions being all reprinted in the volume before us. The book is now divided into three parts, of which the first is devoted to blast-furnace practice, the various brands of pig iron and their intelligent purchase; the second to the elements in cast iron and the use of chemistry in the foundry, and the third to the methods and results of tests. All contain a fund of information for those engaged in foundry work.

"Pacific Type Passenger Locomotives," 48 pp., 6x9 inches. American Locomotive Company, New York. This pamphlet is similar in arrangement to the one just described, but is devoted to the Pacific or 4-6-2 type. In comparing locomotives of the two types it is interesting to note that while the weight on the drivers in the Atlantic type is on the average something over 50 per cent. of the total weight, the percentage in the case of the Pacific type is over 60 per cent. The largest engine shown in this pamphlet is one for the Baltimore & Ohio Railroad, and its total weight without tender is 229,500 pounds. It has three pairs of 74-inch drivers, and a total engine-wheel base of 34 feet, 1½ inches. The boiler has a total heating surface of 3418 square feet, and a grate area of 56.5 square feet. The tubes in the boiler have the great length of 20 feet, which one realizes when looking at the engine, and noting its very lengthy appearance.

"Atlantic Type Passenger Locomotives," 64 pp., 6x9 inches. The American Locomotive Company, New York City. This pamphlet contains a brief discussion of the "Atlantic," or 4-4-2 type of passenger locomotive, and tables of dimensions of 26 examples of this type, built by the American Locomotive Company, followed by elevations and sections of one of them; the greater portion of the book is taken up with photographic views and dimensions of the engines. The largest engine shown is a Cole 4-cylinder balanced compound for the Erie Railroad, the total weight of the engine without the tender being 206,000 pounds; it has 78-inch drivers and a total heating surface of 3622 square feet, and a grate area of 56.3 square feet. The wheel arrangement of the 4-4-2 type affords opportunity for a large boiler having a very ample grate area and heating surface so as to be able to haul within the traction limits of four ordinary wheels, heavy trains at a sustained high speed.

"Text Book on the Strength of Materials." By S. E. Slocum and E. L. Hancock. 314 6x9-inch pages with 170 illustrations. Ginn & Company, Boston, New York, Chicago and London.

In some respects this book is a departure from the usual treatise on its subject, this being especially true as regards the space given to the experimental side which, under the title "Physical Properties of Materials," forms part of the book. The analytical and experimental phases of the subject are thus separated. In some respects the analytical discussion is more complete than is customary, this being especially true of the discussion of flat plates and of curved pieces, hooks, links and springs, the chapter on the latter-named subjects giving the first rational explanation we have seen of the weakness of sharp corners. We note with special satisfaction that the illogical use of the word strain to indicate the change of size under stress is abandoned, the term deformation being used instead. The discussion is not limited to those materials which obey Hooke's law, but includes masonry, foundations, retaining walls and reinforced concrete. We are disappointed at the dismissal of the subject of deep, narrow beams in a single paragraph. Since the beautiful demonstration of the properties of such beams and the drawing of the line of demarkation which circumscribes them by A. E. Guy, it would seem that they are entitled to more than a paragraph concluding with a caution against their use.

"Helpful Hints on Hardening Steel." By J. W. Bennett. 80 pp. 3½x5 in. with 12 line illustrations and frontispiece portrait of the author. Press of the Winter Publishing Company, New Britain, Conn. Price, $1.

The author of this handy little volume has had 35 years of practical experience in hardening and tempering tool steel, and has designed the book as a ready reference work for machinists, toolmakers, die makers and others having to do with steel hardening and tempering. As its title indicates, the book is made up of a series of hints, giving specific instructions for the treatment of various classes of tools and appliances. Thus Hints 1 to 5 deal with annealing operations on carbon and high-speed steels, then follow hints on hardening flanging dies and punches, steel bushings, drawing dies, milling cutters, lathe and planer tools, springs, etc., also instructions for hardening spring collets and numerous other tools in common use in the shops, the lead bath being advocated for the heating of most small tools. Another point taken up is the hardening and straightening of long stay-bolt taps and reamers, and still another hint tells how to prevent taps and chasers from changing in the lead while hardening. The engravings show, besides various tools dealt with in the text, the arrangement of tanks for water and oil tempering baths, a lead-bath furnace and a furnace for heating large dies, etc. The book is in such form as to be convenient to refer to, and the instructions are concise and to the point. The author extends to the purchaser the privilege of asking any questions which may arise from time to time concerning hardening and tempering.

John D. Rockefeller submitted to an interview in Cleveland recently, in which he regretted, or rather expressed regrets, at the tendency to restrict the operations of monopolies and corporations, and he calls this "putting the brakes on national development and limiting opportunity." As Mr. Rockefeller is himself, or has been, the greatest limiter of opportunities we have ever heard of, he should be able to speak with authority in such matters. If anyone seeking an opportunity to develop happened to compete with Mr. Rockefeller, then Mr. Rockefeller immediately set about limiting that person's opportunities, and his success in doing so has been phenomenal.

NEW TOOLS AND MACHINE SHOP APPLIANCES

PISTON-RING GRINDER

At page 466, Part 1, was reproduced a line drawing showing the general scheme of this new piston-ring grinder, and we now illustrate the machine as set up for working; Fig. 1 giving a general view and Fig. 2 shows more clearly the arrangement of the chuck for holding the work. This holder has a shallow recess into which the ring is placed and is bolted to a table which may be moved to or from the grinding wheel by means of the handwheel in front. The vertical shaft extending through the table has near its upper end a finger which enters a hole in the split side of the piston ring and slowly rotates the ring in its seat in the holder. The wall of the latter is cut away at the front near the wheel edge to allow the latter to act upon the work and thus as the work is driven by the shaft its periphery is finished by the wheel with the ring under about the same tension as when in place on the piston. It is obvious that as the ring is revolved in its seat its shape is constantly changing as the high spots are ground off, until the wheel touches all the way around, when the operation is completed. The ring-driving mechanism is actuated by a belt from the spindle, this belt driving a shaft which extends through the column and operates the vertical shaft by worm wheel and universal joints. The lever at the side can be operated to disengage the worm drive and the work may then be turned by the hand wheel. Any desired rate of speed for the work may be obtained by changing the outer pulley on the spindle. The bearings of this machine are dust proof and are tapered for adjustment. An adjustable tension device is also arranged at the rear of the spindle to prevent end play. The machine uses a cup wheel 10 inches diameter and the spindle is driven at 2000 to 2200 turns per minute. The weight without countershaft is 800 pounds. The Graham Manufacturing Company, Providence, R. I., is the builder.

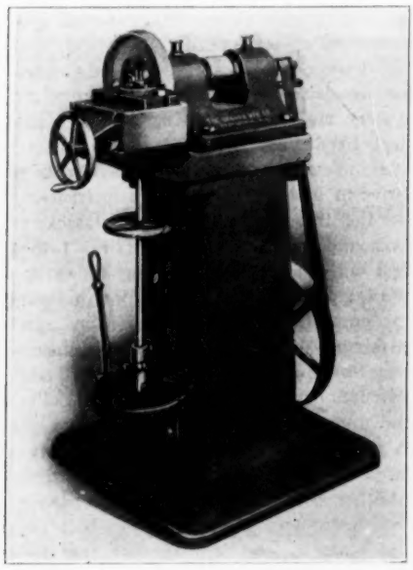


FIG 1. PISTON-RING GRINDER

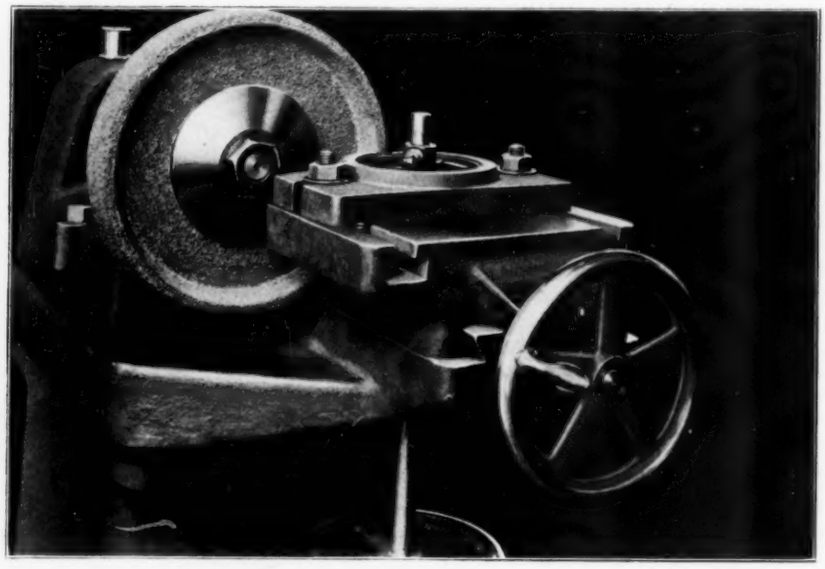
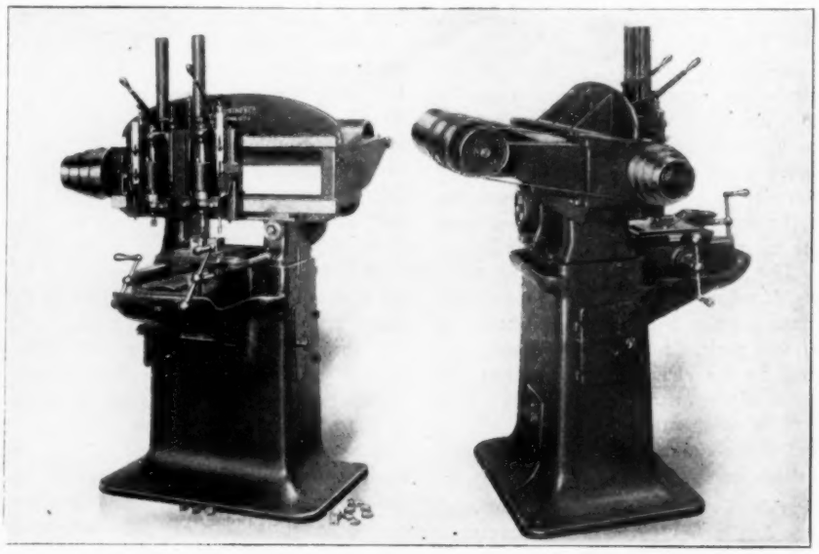


FIG. 2. PISTON-RING GRINDER

TWO-SPINDLE PROFILING MACHINE WITH BELT DRIVE

On this profiling machine, which is designed for high cutter-spindle speeds, say up to 2500 or 3000 revolutions per minute, belt drive is used instead of spiral gears to prevent heating. A three-grade cone at the end of the cross rail drives an 8½-inch drum at the rear of the machine, and upon which the spindle driving-belts travel when the head is moved along the rail. The spindle pulleys are 3 inches diameter for 2-inch belts. These pulleys are mounted on hardened and ground steel sleeves running in bronze bearings, which are fastened to the head, thereby freeing the spindles from belt pull. The spindles are driven by these sleeves in which they have a sliding fit, and run in the same kind of bearings as are used in the regular gear-driven machines. The drum and all of the pulleys are counterbalanced. The countershaft speed is 480 revolutions per minute. The speeds of the machine cone are regularly 675, 480 and



TWO-SPINDLE PROFILING MACHINE

340 revolutions per minute, and the spindle speeds are regularly 1160, 1640 and 2300 revolutions per minute. The machine is built by the Pratt & Whitney Company, Hartford, Conn., and is known as the No. 11 profiler. This form of drive, however, or the gear drive will be applied as required to any of the several sizes of profilers built by this company.

TEST INDICATOR

The illustrations show a test indicator which is of quite simple construction and requires little in the way of a description.

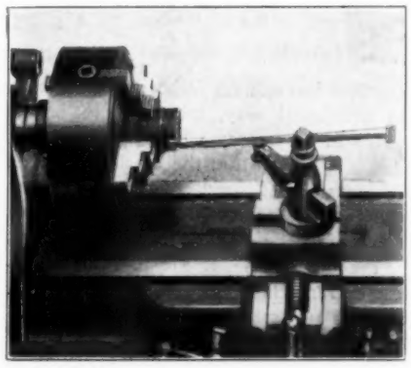


FIG. 1. TEST INDICATOR

Fig. 1 illustrates this instrument as applied to the centering of a piece of work in the lathe chuck, and Fig. 2 shows its application to the locating of a job preliminary to drilling and boring, the contact portion of the indicating arm in this instance being held against an auxiliary bar, the rear end of which is held against the dead center while the pointed end is kept in a center punch mark in the work by spring pressure. As will be observed from the half-tones the pivoted needle or pointer is carried on an arm, which is adjustably mounted at the end of a shank fitting the tool post; a light spring holds the pointer central when not in action. Graduations under the rear end of the

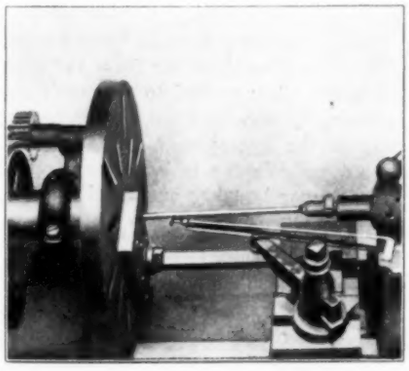


FIG. 2. TEST INDICATOR

pointer read to 2/1000 of an inch, the lines being about 1/32 of an inch apart; the indicator thus has a multiplying movement of about 15 to 1. This instrument is made by A. E. Babin, Waterbury, Conn.

COMBINATION GAGE

The combination tool shown in the accompanying engraving is the subject of a recent patent and is intended to provide a universal tool by which the gage, bevel or angle of any piece of work may be quickly and accurately determined; it is composed of three principal parts. Fig. 1 shows the tool with all the parts assembled; Fig. 2 shows the body or protractor-plate assembled with the gage star-wheel; Fig. 3 shows the association of the protractor-plate and the gage-arm; and Fig. 4 is an enlarged transverse section on the line 4-4, of Fig. 1.

The body-plate *A* of the tool is L-shaped in general contour and its corners are rounded off so as to serve as a male fillet gage having five different radii. It also has a V-notch in one edge for thread tools. Upon the face of the body-plate is engraved a protractor-scale, as shown, and at the center from which the arc is described there is a hole in the body-plate. Through this hole passes the bolt 14, which passes also through the gage-arm

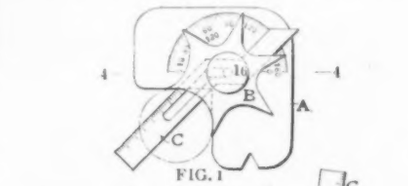


FIG. 1

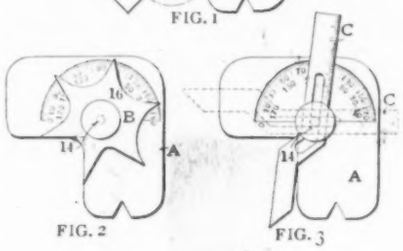


FIG. 2 FIG. 3

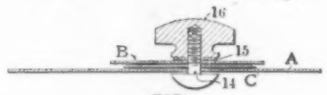


FIG. 4

COMBINATION GAGE

C when it is in use, and through the star-wheel *B*, and next through a washer 15, and finally the threaded end of the bolt is capped by a milled nut 16, as best shown in Fig. 4. The gage-wheel or star-wheel *B* is made so that, as shown in Fig. 2, the edges between any two of the star-points can be made to coincide with the sides of the re-entering angle of the body-plate, and these two straight lines are joined by curves of varying radii, so that the star-wheel forms a female fillet gage. The star-wheel can be readily turned about the bolt 14, and may be then clamped in position by the milled nut 16.

The gage-arm *C*, like the body-plate and the star-wheel, is made of thin metal and is flat on both faces. As will be observed, it has an offset in it and a slotted hole.

Many uses for the complete tool will be evident to a machinist upon examining the drawings. Fig. 1 shows one application, viz., the finding of the center of a round piece of work, the gage-arm *C* being used in combination with the protractor for this purpose. The gage-arm *C* can also be used as a bevel for hexagon nuts, or in combination with the body-plate as a bevel gage either with or without the protractor. The end of the slotted hole in the gage-arm is so located that when the bolt passes through it at that end as shown in Fig. 1, one edge of the gage-arm will be exactly on a radial line passing through the center of the bolt. The protractor may be provided with special marks, such as center-gage, hexagon-gage, etc., so as to increase the convenience of the tool. One end of the gage-arm *C* is made pointed as shown, to be used as a gage in dovetailing and in cutting bastard threads, or when cutting into sharp corners. The gage-arm is provided with a scale on one edge, graduated in inches and fractions. This patent is handled by Herbert Dyke, New Castle, Penn.

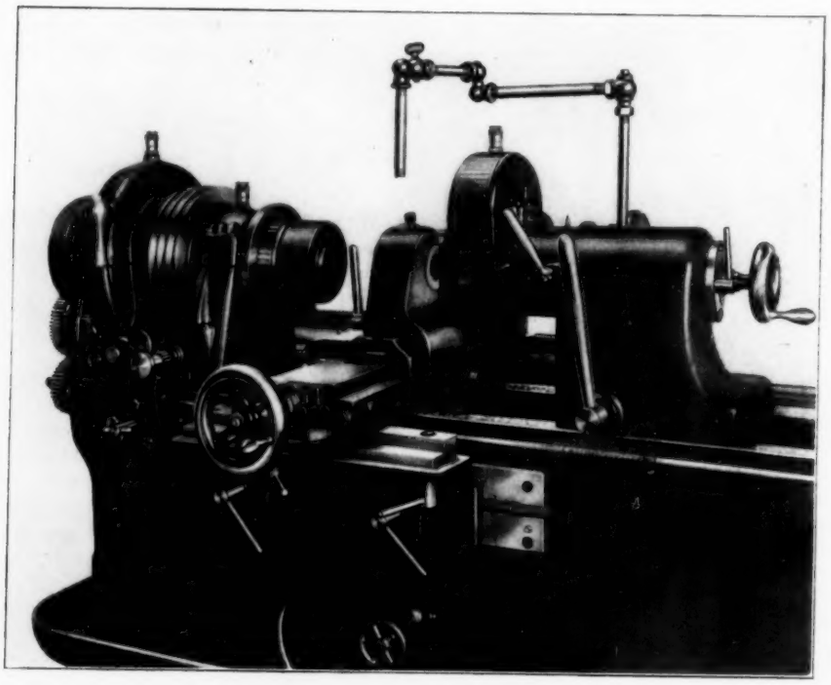
Foreign Postage Again

We have received from the Philadelphia Commercial Museum, a card giving a schedule of foreign postage rates, and calling attention to the importance from a business point of view of American firms putting sufficient postage on all letters addressed to foreign clients. Besides the schedule of regular postage rates for letters, postcards, printed matter, etc., there are also given parcels post rates and a list of the various countries which now have parcels post arrangements with the United States, and by means of which Americans may send merchandise to such countries as Australia, Belgium, Bolivia, Chile, Denmark, Germany, Great Britain, Hongkong, Japan, Korea, Mexico, New Zealand, Norway and others at the rate of 12 cents per pound. Owing to the baleful influence of the express companies and other interested parties, America must pay 1 cent per ounce, or fraction thereof, for the carriage of the same goods from city to city of the same State.

The Federal Grand Jury at Pittsburg has brought indictments against three persons for frauds in connection with supplying steel tubes for navy boilers by the Shelby Tube Company. The fraud is alleged to have been perpetrated by surreptitious use of an inspector's official stamps. Admiral Rae is quoted as saying that no defective tubes have been used as all tubes must stand other tests which insure their suitability. This is not to deny that stamps were fraudulently used. Is local inspection not at all depended upon and are tubes sure to be all right if it is cut out?

Taper Attachment for Thread-Milling Machine

This attachment has been designed by the Pratt & Whitney Company, Hartford, Conn., for their 6x48-inch thread miller and is applied to the machine while it is being built. It is substantially the same in principle of construction and operation as the familiar taper turning attachment used on engine lathes. The taper bar is made in two parts, the one nearest the headstock being secured in a position parallel to the working centers, and the other is made adjustable to suit the required taper. This permits the threading of pieces which have both a taper and a straight portion. The bracket upon which the taper bar is mounted is attached to the front side of the bed, with provision for longitudinal adjustment to suit the location of the taper on the piece to be milled.



TAPER ATTACHMENT FOR THREAD-MILLING MACHINE

The cutter head is carried on a transverse slide, to which is also attached the cross-slide screw with its micrometer disk and positive stop, thus providing means for adjustment for diameter of work and depth of cut, independently of the motion which produces the taper. This latter motion is communicated to the slide through the medium of a positive shoe attached to the slide and in contact with the front side of the taper bar, and a roll under adjustable spring pressure on the rear slide. The greatest angle to which the taper bar may be adjusted is 10 degrees, which corresponds to about 4 inches taper per foot on the work. All adjustments of the bar and the bracket may be made without the use of a wrench.

THE STRENGTH OF CAST-IRON BEAMS

Moment of Inertia by the Tabular Method — Why Breaking Stress Calculated from Flexure Tests Differs from Actual Tensile Strength — The Shifting of the Neutral Axis

The correspondence brought out by Mr. Osborne's little beam problem has been very interesting, both in matter and in form of expression. I certainly take issue with the correspondent who figured out what he called the bending strength and thinks the *closeness* (his italics) of the two results satisfactory. Now it is the very closeness of the results which makes one distrust Osborne's figures. In the first place, is it worth while to attempt to figure the breaking strength of a cast-iron beam? I hardly think that it is, as it is safe values within the elastic limit that govern in practical design. In the second place, if the breaking strength is insisted upon can we find it, observing Osborne's other prescribed limitation, that is without a confusing limitation of *x's*, *y's* and *z's* with their attendant subs and primes, large and small? Let us put the beam formula in its simplest form. Here is the way a correspondence-school man gave it to me.

MNEMONICS FOR MOMENTS

Bending moment (of load) = resisting moment (of beam) $= \frac{WI}{K} = \frac{SI}{c}$, K being a factor depending on the method of loading. Now putting K on the other side of the equation, we have $WI = \frac{SIK}{c}$ and as this is the fundamental formula for all strength of beam questions and is of constant application, we can easily remember in this way, as my friend said: "Weight by the load makes me *SICK*" $\left(\frac{SIK}{c}\right)$. Now let us try this formula on Osborne's little beam in the usual way, taking S to be the stress in the extreme fiber on the tension side. We know that the breaking load, or W, was about 1975 pounds, and that l equals 12 inches. We must first find the value of I, the moment of inertia, and of c, the distance from the neutral axis to the extreme fiber on the tension side.

FINDING MOMENT OF INERTIA BY THE "TABULAR" METHOD

The best method of finding the moment of inertia is that known as the tabular method. The principle on which this is based and several examples of its application to crane girders were shown in the AMERICAN MACHINIST at page 939, Vol. 21 (1898), by E. H. Dixon and at page 127, Vol. 23 (1900), by A. D. Williams. In its direct tabular form it is given in the earlier editions of Molesworth's "Pocket-book" as "Hepple's method," and is also given in the *Practical Engineer* "Pocket-book." The same tabular form extended to include a number of check columns was explained by Sanford H. Moss in *Machinery*, and its application to the more complicated section of a punch frame shown. The same method is given in Johnson's "Modern Framed Structures," which, by the way, contains a very clear and most concise treatment of the whole beam problem.

These references make it unnecessary to do more than show the form and give the results when applied to Osborne's little beam. It may be noted, however, that most of the quantities required can be taken directly from a table of squares and cubes, or may be taken out by slide rule.*

b = breadth of element (see the sketch in connection with the table).
y_2 = distance to the farthest fiber from the axis $X-X$.
y_1 = distance to the nearest fiber from the axis $X-X$.
Then,

$$I = \frac{b\,(y_2^3 - y_1^3)}{3}.$$

In the case of Mr. Osborne's beam, we have, for the web, $b_w = \frac{1}{4}$ in., $y_2 = 1$ in., $y_1 = \frac{1}{4}$ in.
Area of web $= b_w\,(y_2 - y_1)$: numerical values are given in table.

*For convenience of reference we reproduce here the formula referred to for finding the moment of inertia I of any element about an axis X-X parallel to its own neutral axis, and show its application to the problem. The notation is made to correspond with that in the calculations in this article.

Moment distance
$$= y_1 + \frac{y_2 - y_1}{2} = \frac{y_1 + y_2}{2}$$
Moment of area
$$= \frac{b_w (y_2 - y_1)(y_2 + y_1)}{2} = \frac{b_w (y_2^2 - y_1^2)}{2}.$$

And for the flange, we use the following values: $b_f = 1$, y_1 (instead of y_2) $= \frac{1}{4}$ in.; y_0 (instead of y_1) $= 0$

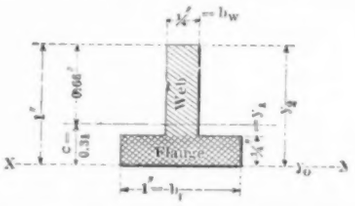
Area of flange $= b_f (y_1 - y_0)$.

Moment distance $= \frac{y_1 + y_0}{2}$.

Moment of area
$$= \frac{b_f (y_1 - y_0)(y_1 + y_0)}{2} = \frac{b_f (y_1^2 - y_0^2)}{2}.$$

In this latter case, the smaller y value being equal to zero does not affect the numerical result, but the symbol is retained for the sake of uniformity.—Ed.

The calculations are as follows:



Breadth of Element.	Ordinate.	Ordinate²	Ordinate³	Area of Element.	Moment of Area About Axis X—X	Moment of Inertia About Axis X—X.
Flange $b_f = 1.00$	$y_1 = 0.25$	$y_1^2 = 0.0625$	$y_1^3 = 0.0156$	$b_f (y_1 - y_0) = 0.25$	$\frac{b_f (y_1^2 - y_0^2)}{2} = 0.0312$	$\frac{b_f (y_1^3 - y_0^3)}{3} = 0.0052$
Web $b_w = 0.25$	$y_2 = 1.0$	$y_2^2 = 1.0$	$y_2^3 = 1.0$	$b_w (y_2 - y_1) = 0.1875$	$\frac{b_w (y_2^2 - y_1^2)}{2} = 0.1172$	$\frac{b_w (y_2^3 - y_1^3)}{3} = 0.0820$
Total Beam.				0.4375	0.1484	0.0872

[Note—The quantities expressed by letters are inserted in the table merely to make the method clearer to the reader; in practice the numerical values only need be written—Ed.]

Distance from axis X—X to neutral axis $=$
$$c = \frac{\text{moment of areas}}{\text{area}} = \frac{0.1484}{0.4375}$$
$$= 0.34 \text{ inch.}$$

Moment of inertia about neutral axis $=$ moment of inertia about X—X — area $\times c^2 = 0.0872 - 0.4375 \times (0.34)^2 = 0.0872 - 0.0505 = 0.0367$.

FIGURING THE STRESS FROM THE TRANSVERSE STRENGTH

Having the value of $I = 0.367$ inch and $C = 0.34$ inch, we can now transpose our formula, substitute these numerical values and find the value of S.
$$S = \frac{W l c}{I K} = \frac{1975 \times 12 \times 0.34}{0.0367 \times 4}$$
$$= 54{,}900 \text{ pounds.}$$

Let us turn the beam head up and we now find the breaking load to be about 1025 pounds and the distance from the neutral axis to be 0.66 inch. Using the same formula, our fiber stress
$$S = \frac{1025 \times 12 \times 0.66}{0.0367 \times 4} = 55{,}400 \text{ pounds.}$$

Our figuring has been perfectly general in form and applies to a beam of any material, but in this case we are considering only the breaking strength and our values of S so far exceed the known tensile strength of the material that we must seek some other justification for its use before we can apply this value to similar beams.

OTHER REFERENCES ON CAST-IRON BEAMS

Let us see what other fellows have done with cast-iron beams. First take Osborne's friend Trautwine. Go back to the time when cast-iron beams were in common use. Let us take Trautwine's first edition (early editions are always interesting, they are so much more individual), and look up in "Strength of Materials" the subject of transverse strength. Here we find a table of coefficients for transverse strength based on a series of experiments on beams one inch square and one foot long, and the very good advice is given that students should make similar experiments and work out coefficients in their own practice. This note is followed by a remark that some materials have peculiarities which diminish the reliability of constants derived from experiment and so we must use judgment and caution in using them. Here we also find the basis of the fact that the breaking load of a cast-iron beam one inch square, one foot long is one ton. Handy thing to remember.

Suppose we apply our fundamental formula for beams to this one and find the value of S, or as Trautwine calls it, the "constant for rupture."
$$S = \frac{2000 \times 12 \times \frac{1}{2}}{4 \times 1\frac{1}{2}} = 36{,}000 \text{ pounds.}$$

Now the breaking load was 2000 pounds and S the constant for rupture 36,000 pounds, or 18 times the breaking load, and Mr. Trautwine after attributing this statement to Professor Rankine and saying that he does not know why it should be so, goes on using it, as in his example quoted a little further on. "Use simple mathematics and back it up by experiment" is the lesson a young man may learn from Trautwine, who seems to have had a most righteous contempt for the authorities—witness the following: "In view of the obscure style of expressing themselves, and the innumerable typographical errors with which their learned hieroglyphics abound, it is almost impossible for a merely practical man to assure himself that he understands anything in the leading authors on mechanics and engineering. To advertise and sell such books as being adapted to the use of practical men is sheer swindling. In the writer's opinion, experiment alone can furnish satisfactory practical rules on this and kindred subjects."

EXAMPLES FROM TRAUTWINE

And so after discussing Hodgkinson's form of beam at some length we find a few examples from actual practice.

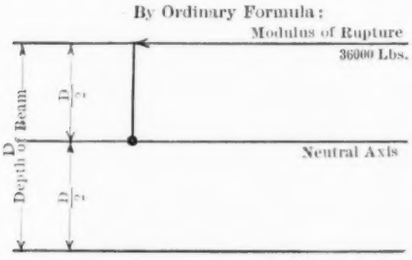
Example: A T-beam with flange or head up and web down; breadth of flange 1.5 inches; thickness of web, 0.5 inch; depth of beam over all 3 inches; thickness of flange 0.5 inch. This beam broke with a load of two tons, giving S a value of about 58,000 pounds, and when inverted it broke with loads of from 2.3 tons to 2.9 tons with S equal 48,000 to 60,000 pounds. This is reasonably consistent.

Example: A T-beam with flange up and web down; breadth of flange 4 inches; thickness of web 0.25 inch; depth of beam over all 1.36 inch; thickness of flange 0.25 inch. This one broke with a load of 0.125 ton, and when the head was down with 0.4 ton, S having a value of 22,000 to 27,000 pounds.

WHY BREAKING STRESS CALCULATED FROM FLEXURE TESTS DIFFERS FROM ACTUAL TENSILE STRENGTH

Now it will be seen that S is usually much more than the tensile strength and in the case of rectangular beams is from 1½ to 2¼ times its strength in tension. This fact the text books repeat, parrot like, one after the other. If we use the breaking load on a beam and from it calculate the coefficient of rupture S, or as it is commonly called the "modulus of rupture," the result is a quantity that does not represent any actual stress in the fiber at all. It is simply convenient to use it in a formula which assumes that the neutral axis at the instant of rupture passes through the center of gravity of the section. The value that may be assumed for S varies with so many conditions, such as the size and shape of the casting, method of pouring, quality of metal, etc., that the best that we can do in a given case where all the conditions are known is to use our judgment and make a guess. Now there is a man named Keep who has written lots of interesting stuff about cast iron and the effect of various elements on the shrink-

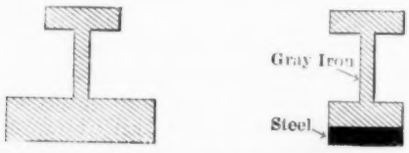
age, hardness and cross-breaking strength, and Johnson in his "Materials of Construction" gives a diagram which shows the effect that one of these elements, silicon, and the size of the bar have on the modulus of rupture.* With 2 per cent. silicon the modulus of rupture increases from 28,000 pounds in a bar four inches square, to 38,000 pounds in a bar one inch square, and to 52,000 pounds in a bar ½ inch square. There have been all sorts of theories to account for this high value of S and one of the oldest ones practically agrees in its results with the accepted modern one that at rupture the neutral axis no longer passes through the center of gravity but moves up somewhere on the compression side. Old Galileo assumed the neutral axis to be at the opposite side of the section and that the material was incompressible. The thing reduces to a question of leverages and may be shown thus in the case of a cantilever beam:



To go much further we get into stress and strain diagrams and all sorts of forbidden mathematics in our search for the neutral axis, and in the case of cast iron it is not worth while.

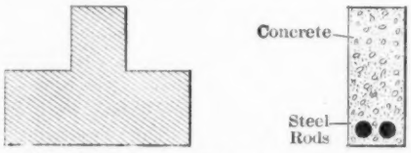
SOME OTHER BEAM QUESTIONS

We have all had a good time with Osborne's little beam; now let us change its form slightly; suppose we go beyond Mr. Hodgkinson's beam and strengthen the lower flange with a bar of wrought iron or steel, like the frame of the Franklin portable hoist, thus:



Where is the neutral axis now?

Or suppose we make our inverted T-beam of concrete which, like cast iron, has a tensile strength very much less than its compressive strength, and instead of the large mass of concrete in tension substitute steel bars, thus:



Where is the neutral axis and what is the breaking strength of this kind of beam?

TAYLOR.

* At page 273, Vol. 29, Part 2, we published an article by Mr. Keep containing information on these matters.—ED.

The Baldwin Statue in Philadelphia —Unveiling of a Fine Bronze to the Founder of the Baldwin Locomotive Works

We have received from the Baldwin Locomotive Works a 20-page pamphlet (Record No. 58, 1906, 6x9 in.) entitled "Ceremonies at the Unveiling of the Statue of Matthias W. Baldwin." This statue, which the Baldwin Locomotive Works presented to the city of Philadelphia through the Fairmount Park Art Association, was raised on a granite base in the little park at Broad and Spring Garden streets, by nine gray-haired master machinists, who served under Mr. Baldwin as apprentices. The statue is of bronze, is 8 ft. high above the pedestal and is the work of Herbert M. Adams. The figure of the famous locomotive builder faces the office building of the works and is represented standing in meditation, with a drawing for a locomotive in one hand and a compass in the other. His life history has been frequently told; we will mention here simply a few of the principal points.

Born in Elizabeth, N. J., in 1795, Matthias William Baldwin learned the trade of manufacturing jewelry at an early age and soon began to show inventive ability, which led him to the establishment of a small machine shop. He built himself a 6-horse-power engine to drive his shop, which engine later did service for fifty years in the Baldwin Locomotive Works. A locomotive imported in 1830 for the Camden & Amboy Railroad interested him exceedingly, and in April, 1831, he built for Peale's Philadelphia Museum a miniature engine which drew two cars, each holding four persons. This was Mr. Baldwin's first locomotive, and it led to his receiving an order for his first full-sized engine ("Old Ironsides," weight five tons) from the Philadelphia & Germantown Railway. He had to do most of the work himself and to train such help as he had, so it took nearly a year to build the machine, and it did not start running until November, 1832. The engine was advertised to make daily trips "when the weather was fair"; in rainy weather the cars were drawn by horses. The history of the growth of the Baldwin Locomotive Works from this small beginning to the present great establishment, employing over 17,000 employees and capable of producing eight locomotives a day, is closely allied to the history of the development of America's great network of railroads. Besides the building up of this great industry, Mr. Baldwin was in other ways a public benefactor and a valuable citizen of the city of Philadelphia and the State of Pennsylvania, and conspicuous for his philanthropic and upright life, so that the erection of this statue to him opposite the works which have contributed so much to the prosperity of Philadelphia is an entirely appropriate action on the part of his successors.

Ireland's International Exhibition

Ireland's forthcoming International Exhibition, which will be open from May to October, 1907, will be the biggest undertaking of its kind ever organized in that country. More than 1000 individuals have subscribed to the guarantee fund, which now exceeds $900,000 and is constantly growing; and work on the buildings has gone on so rapidly that they will be finished some months before the day set for opening, May 1, 1907. Machinery Hall is already completed.

Various foreign countries are making preparations to send exhibits. The French section will equal that at the exposition at Liège; and Russia, Italy, Canada, Australia and other countries will be well represented.

Exhibits will be classified in nineteen sections, a few of which are as follows: Irish Industries, History and Education, Fine Arts, Liberal Arts, Manufactures, Textiles, Engineering and Shipbuilding, Civil Engineering and Transportation, Electricity, Mining and Metallurgy, Agriculture and Food Products.

Opposite the main entrance will be the principal building, consisting of a central octagonal court, 215 feet in diameter, surrounded by a corridor capable of accommodating 7000 people. The total area of the central building will exceed 100,000 feet. Around this will be grouped the pavilions for the British, foreign and colonial exhibits. The machinery building will be 900 by 100 feet, giving a floor area of 92,000 square feet. Altogether, the exposition will cover 52 acres of ground.

The site, at Herbert park, Dublin, is well adapted to the purposes of the exposition. It is situated in the residential quarter of the city, within a mile and a half of its business center. Three lines of tramways will connect the exposition with all parts of the city and with the termini of the various railways running from Dublin to the north, south and west of Ireland. Transportation for exhibits is readily obtainable. Particulars as to space,

power, etc., may be obtained from the secretary, James Shanks, Ballsbridge, Dublin, Ireland.

Personal.

E. C. Berghoeffer, for many years an engineer with the Chicago house of the Link-Belt Company, is now in charge of the office which that company has recently opened at No. 913 Missouri Trust Building, St. Louis, Mo.

Frederick T. Craig, for five years superintendent of the manufacturing department of the Knox Automobile company, Springfield, Mass., severed his connection with that concern November 1. He was presented with a handsome diamond ring by the employees of the company as a token of the esteem in which he was held. Mr. Craig was associated with Harry Knox, the founder of the business, during his early experiments with gas and gasolene engines, and he took charge of the machine department soon after the company began to manufacture motor vehicles.

Obituary

Amos B. Armstrong, a master mechanic at the Penn Steel Works, Chester, Penn., died November 5, aged 62 years.

Frank D. Nacke, of the firm of Arnold Nacke & Son, machinists, died at Philadelphia, Penn., recently, 31 years old.

Carleton Walworth Nason, president of the Nason Manufacturing Company, New York City, died of pneumonia November 4, at his home on East Seventy-second street. He had been ill for a week. The Nason Manufacturing Company was founded by Henry R. Worthington and Joseph W. Nason. C. W. Nason succeeded his father in the business and was himself an inventor. He was a charter member of the American Society of Mechanical Engineers and president of the Motor Cycle Club. Mr. Nason took much interest in the work of the A. S. M. E., was chairman of its committee on Standard Pipe Flanges and a manager from 1889 to 1892.

Manufacturers

The Poughkeepsie (N. Y.) Button Company will erect a new $30,000 factory.

The Badger Brass Company, Kenosha, Wis., is building an addition to its plant.

The Detroit (Mich.) Brass and Wheel Works will build a $12,500 addition.

The New York Edison Company will erect another new power-house in Manhattan.

A dye house and power plant will be erected for the Angola Dye Works, Philadelphia, Pa.

The Mickle-Dyment Lumber Company, of Brantford, Ont., will erect a new planing mill.

The Health Manufacturing Company, Greendale, Worcester, Mass., will erect a new boiler house.

The Orange and Rockland Electric Light Company will enlarge its plant at Monroe, N. Y.

A new cold-storage plant will be built for the Kingan Packing Company, Washington, D. C.

The Minnesota Hemp Company, Northfield, Minn., will spend $60,000 on improvements at its plant.

The Whitlock Coil Pipe Company, Elmwood, Conn., has awarded contract for a new power-house.

The New England Butt Company, Providence, R. I., is building an addition to its machine shop.

It is reported that the David Maydole Hammer Company, Norwich, N. Y., will erect a large new plant.

The Southern Reduction Company, Baltimore, Md., will rebuild its plant, recently destroyed by fire.

The Chicago (Ill.) Brass Company has appropriated $1,000,000 for buildings at its Kenosha, Wis., plant.

The Cleveland & Southwestern Traction Company will erect a new shop at Elyria, Ohio, to cost $70,000.

The Westinghouse Electric and Manufacturing Company, of Pittsburg, will build a plant in Seattle, Wash.

The Sheldon Axle Company, Wilkes-Barre, Penn., will erect an addition to be used as a rolling mill.

The Battle Creek (Mich.) Smelting and Refining Company has let contract for the construction of a new plant.

The L. Hardy Company, Worcester, Mass., is making an addition to its plant for the manufacture of machine knives.

The McCann Mechanical Works, Los Angeles, Cal., is making additions to its plant, including a new machine shop.

The South Penn Oil Company, of Pittsburg, will begin the construction of a large plant at Clarksburg, W. Va.

The United States Steel Corporation will spend $10,000,000 for new mills and furnaces at its Duquesne, Penn., plant.

The Minneapolis, St. Paul & Sault Ste. Marie Railroad will erect boiler shops in Minneapolis at a cost of $70,000.

The Standard Steel Car Company, of Pittsburg, Pa., has let contract for the construction of a plant in Hammond, Ind.

The Citizens Gas and Electric Company, Oswego, N. Y., a new concern, has started work on its electric power house.

The Foster Engineering Company, Newark, N. J., is making alterations and additions to its plant, which will cost about $10,000.

The Bergen Foundry Company, Jersey City, N. J., a new concern, will build an iron foundry at Fisk and West Side avenues.

The Iron Mountain Railroad Company will erect new repair shops and a roundhouse near its present buildings in Monroe, La.

The Chattanooga (Tenn.) Railway Company is erecting new car shops and barns to cost about $220,000 exclusive of equipment.

The Langeland Manufacturing Company, Muskegon, Mich., planing mill, lumber, etc., will enlarge its factory and erect a new boiler house.

The Denver (Colo.) Lithographing Company will erect a new plant, to be equipped with the latest machinery, at a cost of about $200,000.

The Haines Oil-Measuring Pump Company, York, Penn., with temporary office at 133 North George street, will shortly begin the erection of a plant.

The Butler Manufacturing Company, Syracuse, N. Y., furniture makers, will erect a new plant, to consist of power-house, factory, dry kiln and lumber house.

The Gila Valley, Globe & Northern Railroad will expend $55,000 on a new roundhouse and carshops at Globe, Ariz., to replace those recently destroyed by fire.

The William Cramp & Sons Ship and Engine Company, Philadelphia, Penn., has taken out a permit for two additions to its foundry which will cost $50,000.

The La Valley Manufacturing Company, Milwaukee, Wis., which will manufacture steel castings, has commenced the erection of a new plant. C. W. LaValley is president.

Stroud & Co., manufacturers of scrapers, grading tools, etc., will make additions to their plant which will include a foundry for making their steel and iron castings.

The plant of Thomas Buckley, Chatham, N. Y., which included saw, planing, shingle, lath, cider and grist mills, was destroyed by fire. Loss $10,000. It will be rebuilt.

The Dixie Portland Cement Company, with a capital of $2,700,000, has been organized by Geo. E. Nicholson, of Iola, Kan., and others. A plant will be erected near South Pittsburg, Tennessee.

The Alton Manufacturing Company, 11 East Twenty-second street, New York, metal specialties, is in the market for automatic screw machine, power press, grinding machine, handscrew press, bench lathe with screw-cutting attachment.

Improvements and extensions to the mechanical departments of the Elgin, Joliet & Eastern and Chicago, Lake Shore & Eastern Railway Company, are about to be made to call for the expenditure of between $4,000,000 and $5,000,000 at Joliet, Ill.

Catalogs

Munn & Co., 361 Broadway, New York. Catalog of scientific and technical books. 6x9 inches, 92 pages, paper.

Theo. Alteneder & Sons, Philadelphia, Pa. Circular illustrating and describing draftsman's pen-filling inkstand.

H. H. Franklin Manufacturing Co., Syracuse, N. Y. 1907 catalog of motor cars. Illustrated, 7x9 inches, paper.

Eureka Wheel Gauge Co., 8-10 South Canal street, Chicago, Ill. Circular illustrating and describing the Eureka wheel gage.

Buckeye Engine Co., Salem, O. Catalog describing Buckeye electric blue printing machine. Illustrated, 4x9 inches, 15 pages, paper.

Niles-Bement-Pond Co., 111 Broadway, New York. Pamphlet containing pictures showing improvements in plants now under way or recently completed. 9x12 inches.

Ingersoll-Rand Co. (Pneumatic Tool Department), 11 Broadway, New York. Bulletin No. 2011, describing Little Jap hammer drill. Illustrated, 6x9 inches, 19 pages, paper.

American Locomotive Co., 111 Broadway, New York. Catalog of consolidation type freight locomotives weighing less than 175,000 pounds. Illustrated, 6x9 inches, 72 pages, paper.

Chicago Pneumatic Tool Co., Fisher building, Chicago, Ill. Catalog describing Franklin air compressors. Numerous interesting tables and formulas are given. Illustrated, 6x9 inches, 116 pages, paper.

Rockwell Engineering Co., 26 Cortlandt St., New York. Pamphlet No. 9 describing Rockwell heating machines (oil or gas fuel) for annealing, hardening, tempering, coloring, etc. Illustrated, 6x9 inches, 8 pages, paper.

L. O. Koven & Brother, boiler manufacturers, Jersey City, N. J., are erecting an addition to their plant which will be devoted to the construction of special machinery. A power-house will also be erected and all the machinery run by electricity.

Miscellaneous Wants

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad St., New York.

Wanted—Medium-weight specialties to build. Box 326, AMERICAN MACHINIST.

Universal Test Indicator circulars free. H. A. Lowe, Lock Box 146, Cleveland, O.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machry. to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Dies and Diemaking, $1.00. A shop book by a shop man. J. L. Lucas, Bridgeport, Ct.

Novelty in tool or machine specialty wanted. Particulars required. Box 202, AMER. MACH.

Special mach. to order. Inventions developed. Geo. M. Mayer, M.E., 1131 Monadnock Bk., Chicago, Ill.

Special machinery designed and built. Walter S. McKinney, M. E., 43 Broadway, Flushing, N. Y.

Tools, dies and special machinery built by contract. Chas. Crabb Co., 635 Kent avenue, Brooklyn, N. Y.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Boston architect or engineer desiring to divide office, telephone and stenographic expenses. Address Box 331, AMER. MACHINIST.

Wish to place contract for yearly supply of gray-iron castings, similar to gas-engine castings; about four tons daily. R. X. Y., Box 283, AMERICAN MACHINIST.

Will pay five dollars for catalog in good condition of American Engine Co., 1894, illustrating horizontal and vertical engines. Box 327, AMERICAN MACHINIST.

Special high-grade machinery built to order. Automatic and otherwise; electrical work a specialty. Complete modern equipment. Automatic Machine Development Company, 130 East 12th street, New York.

Engineers' Handbook of Standard Dimensions of Details and Machinery, 250 blueprinted tables, leather bound, sent prepaid on receipt of price, $3.50. M. Neumayer, M. E., First National Bank Building, Cincinnati, O.

Not using the whole of our modern factory plant, we should like to take up the building of any small high-grade machines, or parts of machines, in large or small quantities. United Sewing Machinery Company, Springfield, Mass.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Grinder patterns for sale — Bench, floor, small surface, water-tool grinders, buffing lathes and a few special machines; drawings included; can hold trade if taken quickly. A bargain for someone. J. H. Wylie, Holyoke, Mass.

Mechanical engineer, holding responsible position with large firm manufacturing machine tools, having made a specialty of wet grinding machinery, is in position to take up considerable outside work, consulting or designing. Address Box 318, AMERICAN MACHINIST.

Wanted—By one of the largest and most important firms of crucible steel manufacturers in Sheffield, England, a representative for the United States. Only firms in a position to give first-class references need apply. Address "A B.," care T. B. Browne's Advertising Offices, 163 Queen Victoria St., London, E. C., England.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

Business Opportunities

Wanted to contract with shop within 50 miles of New York City, equipped for making highest-grade automobile chassis. Must have capacity for at least 100 cars per year and able to do highest grade interchangeable work cheaply. No body work. Box 210, AM. MACH.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the construction of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Two second-hand cupolas in first-class condition; shells 72"—82" in diameter and about 40 feet high. Box 333, AM. MACH.

Bankruptcy Sale—Denver Iron and Wire Works—Real estate, fixtures and personalty; two plants appraised at $17,000 and $58,000; best equipment between Missouri River and Pacific Coast. Public sale November 21, 1906. Rodney J. Bardwell, Denver, Colorado, Trustee in Bankruptcy.

Wants

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Position as superintendent; practical, systematic and fully reliable, with wide knowledge in machine and foundry practice; permanent position desired; will consider nothing less than $3000 the first year; correspondence strictly confidential. Box 311, AM. M.

NEW JERSEY

Situation wanted—Young man, seven years' foundry, pattern and machine-shop practice, technical graduate, desires position as draftsman. Box 323, AMERICAN MACHINIST.

Mechanical engineer, college graduate, wide experience in shop and office solely in gas producers of the suction and pressure type and producer-gas engines, designing, gas analysis, testing; can introduce new type of good paying suction producer and wishes to connect with enterprising manufacturer for responsible situation; holds at present position as general designer with first-class concern. Box 305, AMERICAN MACHINIST.

NEW YORK

Machine shop and foundry superintendent, with good business experience, desires change; executive, progressive, successful; present position outgrown. Address Box 288, AM. M.

Wanted—By mechanical engineer, position as superintendent or manager of machine works; special ability in installing systematic methods of manufacture. Box 317, AM. M.

Wanted—Position by experienced designer of alternating and direct-current motors and generators and high-speed motor trucks; technical graduate. Box 329, AMER. MACHINIST.

Inventor, with 10 years' experience in steam engines, automatic machinery, die work and steam turbines, is open for a first-class engagement. Box 252, AMERICAN MACHINIST.

General foreman—successful in the modern economical manufacture of high grade interchangeable and special machinery, varied experience, master mechanic—desires change; age 36; salary $1500. Box 322, AM. MACH.

VERMONT

Mechanical draftsman wants engagement; 12 years' experience on hydraulic machinery, steam and power pumps, gate valves, fire hydrants; first-class designer. Box 328, AM. M.

VIRGINIA

Mechanical draftsman, 36 years of age, with 15 years' experience on general steam-engineering work, wishes to change position. Box 330, AMERICAN MACHINIST.

WISCONSIN.

Man with several years' experience at designing special machinery and tools wants a responsible position; technical, practical and reliable. Box 319, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted — Toolmakers experienced on fixtures, dies and gages. Applicants should give age, experience and wages expected. Ross Rifle Co., Quebec, Canada.

Wanted — An experienced tool designer, small interchangeable parts made in large lots; range of tools—punches and dies, jigs, milling fixtures, screw-machine fixtures and cams; a good opening for the right man. The Northern Electric & Manufacturing Co., Ltd., Montreal, P. Q.

CONNECTICUT

Wanted—First-class operator on Jones & Lamson turret lathe; also one first-class all-around machinist. The New Machine Co., Danbury, Conn.

Wanted — Tool makers, die sinkers, drop forgers and men familiar with grinding machines. Apply to D. P. Beckwith, Pope Manufacturing Company, Hartford, Conn.

ILLINOIS

Wanted—By large wagon factory, experienced mechanical draftsman for work on traction trucks and heavy wagons. Box 238, AMERICAN MACHINIST.

Wanted—First-class mechanical draftsman with inventive ability to design bottle-labeling and other bottling machinery; state experience, reference and qualifications; good position for able man. Box 304, AM. MACHINIST.

Wanted—Technical man to take charge of our tempering department; one experienced in tempering all kinds of tool steel preferred; tempering room is one of the finest equipped in central West. H. Mueller Mfg. Co., Decatur, Ill.

MASSACHUSETTS

Superintendent—Manufacturing plant, 500 hands, wants a man of experience to take charge of manufacturing; first-class man, with good reference. Box 307, AMER. MACHINIST.

Mechanical draftsman wanted on medium weight special automatic machinery; shop located in eastern Massachusetts; please send age, experience and references; steady work and good pay. Box 298, AMER. MACHINIST.

Wanted—Two first-class machinists and one screw-machine operator; must understand Gisholt lathe; steady positions to competent men; state age and wages expected; factory near Boston. Box 270, AMERICAN MACHINIST.

An assistant superintendent for an iron foundry and machine shop employing about 350 men; must have good executive ability and be familiar with methods that produce results; state age, references, synopsis of experience and salary expected. Box 314, AMERICAN MACHINIST.

Wanted—By a company already building a line of high-grade grinding machinery, an expert draftsman who has had experience in designing machines for plain and internal grinding, and is competent to have charge of one or two detail men. Please give full information as to experience, age and salary expected, which will be held strictly confidential. Address Box 321, AMERICAN MACHINIST.

MICHIGAN

Wanted immediately—First-class diemakers for sheet metal; married men preferred; steady employment. Apply in person or by letter to Michigan Machinery Mfg. Co., Ypsilanti, Mich.

NEW HAMPSHIRE

Wanted—A draftsman experienced on machine tools; state experience and wages expected. Address Flather & Co., Inc., Nashua, N. H.

NEW JERSEY

Several first-class tool and diemakers accustomed to high-grade work; steady employment and good wages to competent men. Sloan & Chace Mfg. Co., Sixth avenue and Thirteenth street, Newark, N. J.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

NEW YORK

Wanted—Experienced men on general tool work. Box 299, AMERICAN MACHINIST.

Wanted—Draftsman with some experience on jigs; salary $16 per week. Box 313, AMERICAN MACHINIST.

Wanted—First-class man to make dies for punch-press work; steady position. Oneida Community, Ltd., Sherrill, N. Y.

Wanted—A first-class foreman boilermaker to take charge of boiler shop; New England. Box 316, AMERICAN MACHINIST.

Wanted — Experienced draftsmen, toolma-

kers and machinists; give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

At our new factory—Toolmakers experienced in fine and complicated work; steady employment and good wages. Jones Speedometer Co., New Rochelle, N. Y.

Draftsmen on jigs and fixtures for duplicating work; none but experienced men wanted; good pay for right men. Mergenthaler Linotype Co., 20-42 Ryerson St., Brooklyn, N. Y.

Wanted—Mechanical and electrical draftsmen. Apply, giving age, experience and salary expected. Engineer in Charge, Drafting Department, General Electric Co., Schenectady, N. Y.

Man wanted to represent us on the road; one acquainted with babbitt, solder and type-metal trade and preferably employed at present. This is a good opportunity for the right party. Box 266, AMERICAN MACHINIST.

Wanted—Foreman in machine works, manufacturing woodworking and other machinery; must be thoroughly competent, with executive ability, who knows how to handle men and tools to best advantage; state age, experience and salary expected. Box 324, AM. MACH.

OHIO

Machine-tool draftsmen wanted for Ohio; detailers or designers. Box 245, AM. MACH.

A man competent to take charge of tap and die department may learn something interesting by addressing Box 308, AMER. MACH.

Several first-class draftsmen, thoroughly familiar with steam-hammer designing; state experience, age and salary expected. Box 301, AMERICAN MACHINIST.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

PENNSYLVANIA

Wanted—Draftsman on high-grade engine work. Box 332, AMERICAN MACHINIST.

Wanted—Superintendent for machine shop building hoisting engines, and general work; small shop. Box 325, AMERICAN MACHINIST.

Wanted—Department foreman for gear-cutting plant; must have experience. Address, with full particulars, Box 320, AMER. MACH.

Wanted—Ten machinists, general machine and bench hands; also two A-1 patternmakers. Apply to Scottdale Foundry and Machine Co., Scottdale, Pa.

Wanted—Experienced operator for Jones & Lamson lathe; steady work in a good town. Write Wilson Laundry Machinery Company, Columbia, Lancaster County, Pennsylvania.

Machinist experienced in running double-stroke headers; good wages and permanent position to first-class man. Metallic Specialty Mfg. Co., 1616-1628 North 21st St., Philadelphia, Pa.

Wanted—Machinist and diemaker, also superintendent who can handle men to advantage and get maximum product at minimum cost; manufacturers of hardware and wooden ware specialties. Address "Ely," AM. MACH.

Wanted—Lathe foreman capable of producing good work at minimum cost for growing shop now employing forty (40) hands; good opportunity for the right man. Wilson Laundry Machinery Company, Columbia, Lancaster County, Pennsylvania.

Machine-shop foreman wanted, preferably young man with technical education; must be thoroughly able to get the maximum amount of work from the machines under his control; state experience, qualifications, salary expected, and references. P. O. Box 3047, Fairhill Station, Philadelphia.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections, these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND

Wanted—First-class milling-machine man to take charge of 12 machines. Box 300, AM. M.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN

Wanted—For accurate gear cutting, a competent man who will instruct and supervise, also operate machines on automobile work; open shop; good surroundings. Thomas B. Jeffery & Company, Kenosha, Wis.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

WEST OF MISSISSIPPI

The J. Geo. Leyner Eng. Wks. Co., of Littleton, Colo., are increasing their plant and are in need of good mechanics, machinists, blacksmiths and sheet-iron workers. Littleton is a suburb of Denver, where cost of living is reasonable; superb climate the year round. Address above.

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A MACHINE FOR GRINDING CONCAVE FRICTION DISKS

A New Application for the Grinding Machine

BY H. F. NOYES

This machine was designed to grind the friction disks used to obtain speed variations in the traverse mechanism of the Landis grinding machine, one size of which is shown in Fig. 1. The method of roughing out these disks on the turret lathe and the fixture used for the purpose have been described and illustrated in the AMERICAN MACHINIST at page 806, Vol. 29, Part 1.

In the design of this machine, in order to save time and expense, it was desired to use, as far as possible, details from one of the machines regularly manufactured by this company. Their regular No. 4 universal machine was chosen, and of it the overhead works, bed, traverse driving mechanism, wheel base, and a portion of the reversing mechanism were used, with little or no change.

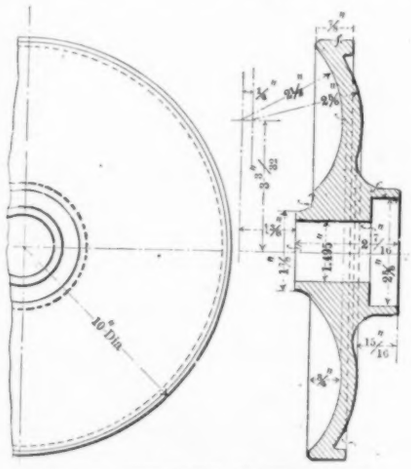


FIG. 1. THE WORK TO BE GROUND

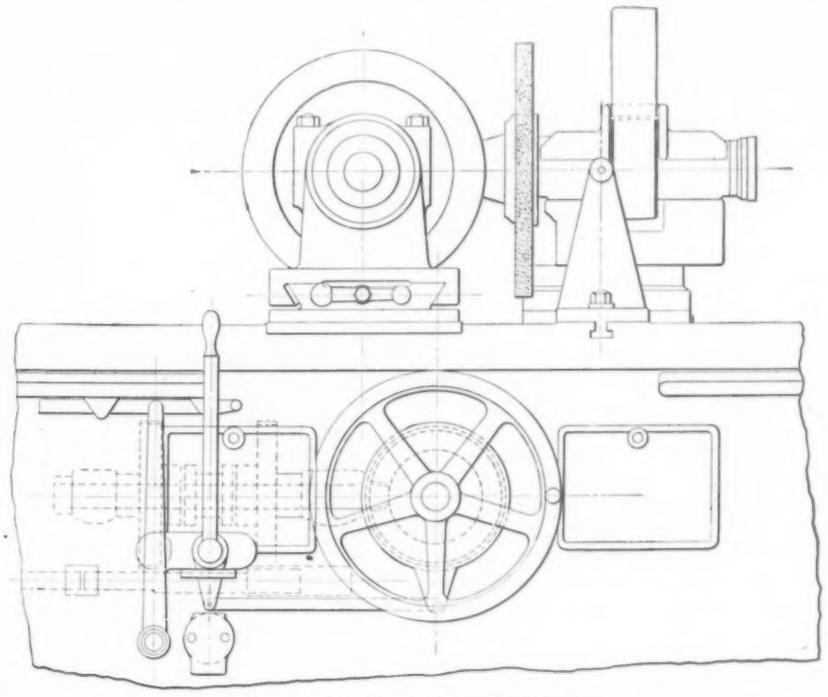


FIG. 2. FRONT VIEW OF THE MACHINE

Fig. 2 is a front and Fig. 3 a rear view of the machine, both with the work in place.

Fig. 4 is a central cross section; Fig. 5 is a plan of the headstock and table in their relations to the wheel base and carriage; Fig. 6 is a partial cross section taken at line *A A*, Fig. 5 and Fig. 7 a view of the diamond holder.

THE GENERAL CONSTRUCTION

As will be readily apparent, the general plan adopted was that of oscillating the wheel base about a central point, which point is the center of radius of the curved surface of the disk.

Referring to Fig. 4, the wheel base and slider, which are of a regular type, are mounted on a slide which is adapted to oscillate about a center, this center being determined by a large disk *a* which is fastened to the carriage. A portion of the weight of the wheel base and slider is carried upon a roller *c*, which is adapted to ride upon a curved track cast upon the carriage.

To provide a means for oscillating the wheel base, a worm gear *f* is fastened to the slider, fitted to the central disk, and driven by a worm *g*, the operation of which will be referred to farther on.

For this machine the usual automatic traverse of the carriage is unnecessary, and instead the carriage is located at a fixed point by means of a dowel pin, this point having relation to the headstock in accordance with the relation of the center of the radius of the disk to be ground to the headstock; the carriage thus having a locating point for each diameter of disk.

THE REVERSING MECHANISM

The usual traverse driving arrangement is preserved, however, and the automatic reverse is applied to oscillating the wheel base. This is effected as follows: On the regular machines a bevel gear corresponding to the bevel gear *b* is fastened to the hand-wheel shaft *c*, which drives the carriage through a pinion on its end and a rack. In this design the bevel gear *b* is made loose on the shaft, and is provided with a pinion which engages the dog-wheel gear *d*, the regular dog-wheel mechanism and reversing dogs being retained. At the same time the hand-wheel shaft, hand wheel and rack pinion are retained for moving the carriage by hand to other positions when it is desired, and for diamonding the wheel.

The shaft which carries the bevel pinion which engages the gear *b*, is provided with another pinion which, through a chain of gears, Fig. 6, engages and drives the worm shaft for oscillating the wheel base.

THE MAIN SPINDLE

In the headstock of this machine a departure from regular practice is introduced. In order to obtain plenty of weight to absorb possible vibration, and save expense, the face plate and spindle are made in one piece of cast iron, and run in babbitted bearings. While this construction would undoubtedly invite criticism, yet it seems to meet all requisites. There is certainly sufficient strength; weight and body are wanted, and they are

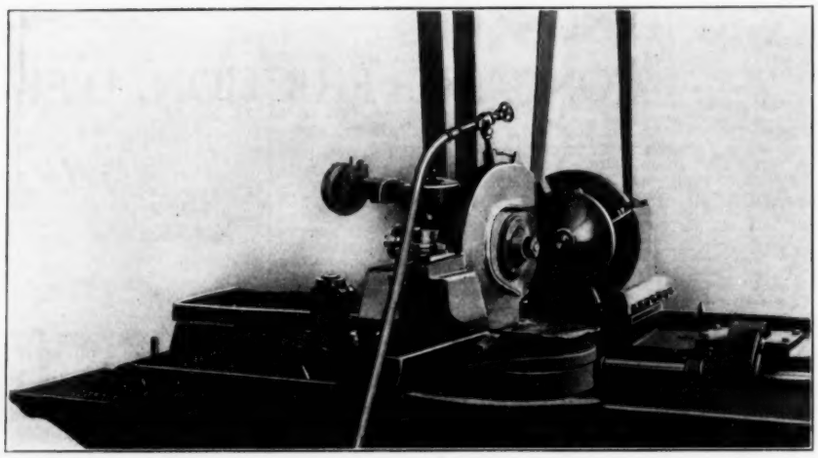


FIG. 3. REAR VIEW OF THE MACHINE

there. It is exceedingly simple to make, and as the speed is low, not over 50 revolutions per minute, this does not raise an objection. Thus far this spindle has given exceedingly satisfactory results. It will be evident that to obtain different radii, the headstock and the wheel base must be adjusted.

THE OPERATION OF THE MACHINE

The first operation is diamonding the wheel to its desired radius, which is effected with the aid of the diamond holder, Fig. 7. A line is marked on the base of the holder, and another on the table to which it is clamped, these lines being so placed that when they coincide, and the diamond is moved forward until it touches the gage supplied for this purpose, the diamond is rightly located for a certain radius. If other radii should be required, they could be readily located from these lines. It is evident that if now the wheel be moved up into contact with the diamond and automatically oscillated the latter will give it the desired radius.

The carriage is then moved to its proper position without disturbing the location of the wheel base on the carriage, and the headstock is moved up until the work touches the wheel, when it is ground to a gage.

In the operation of the machine the desired amount of oscillating movement of the wheel base is obtained by adjusting the reversing dogs in the same manner as they are adjusted to regulate the travel of the carriage on the regular machines.

With this machine the disks illustrated in Fig. 1 have been ground at the rate of 4 or 5 an hour, and a very satisfactory finish obtained.

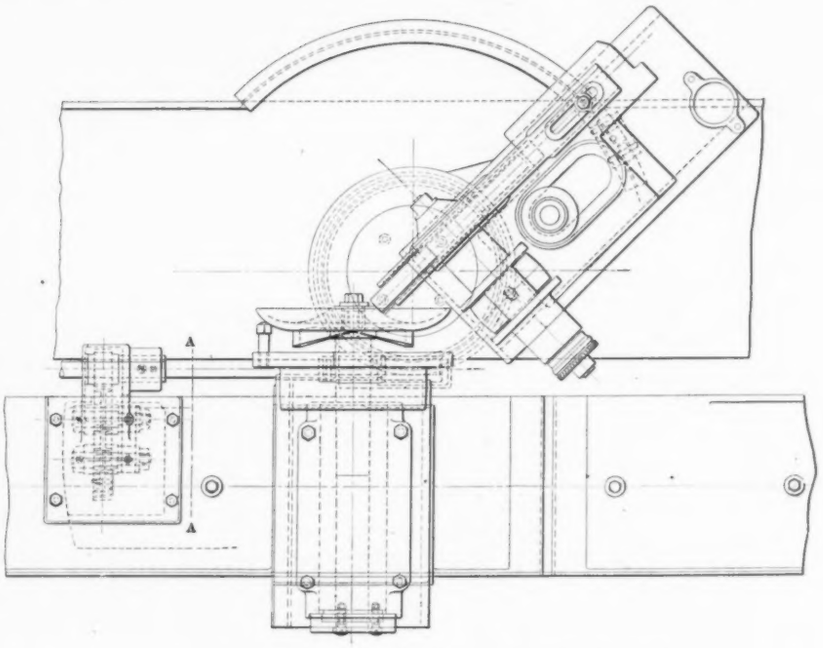


FIG. 5. PLAN OF HEADSTOCK AND WHEEL BASE

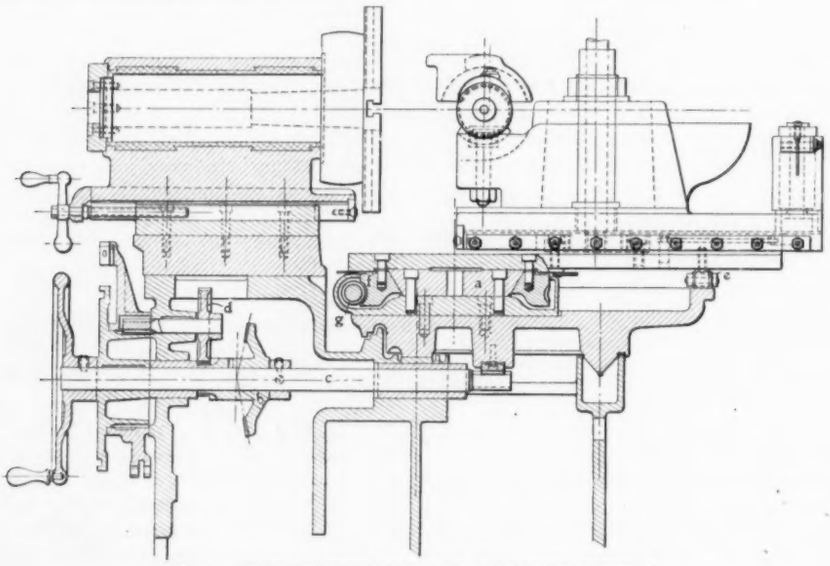


FIG. 4. CROSS SECTION THROUGH HEADSTOCK SPINDLE

Electric Smelting of Iron and Steel

The electric smelting of iron and steel is receiving considerable attention in metallurgical circles. The scarcity of coal and the abundance of water power in Canada have led to extensive experimental work in smelting iron by the Dominion Government, on which an official report has been published. In Europe the electric furnace has been applied to steel making and *Daily Consular and Trade Reports* for Nov. 8 contains a report by U. S. Consul G. E. Eager, of Barmen, on a steel-making plant at Remscheid Haston, Rhenish Prussia. The principal claim for the process as there applied appears to relate to the purifying action of the furnace, whereby high-grade steel may be made from cheap iron scrap.

The first American-built turbine steamer, "Governor Cobb," which went into commission recently will be followed in January by the Southern Pacific Company's "Creole." There will be five turbine steamers in commission on the Atlantic coast in 1907.

ENGINEERING INDUSTRIES IN RUSSIA—IV

Factory Laws and their Effect Upon Employers and Workmen—Relief for Injured Employees—Strikes and Rebellion—The Future

BY CHARLES PRESCOTT FULLER

Relative to fines which may be levied on work people, the Russian factory law states in its provisions pertaining thereto: "Having in view the maintenance of order, necessary in a works, the managers of such works are empowered to levy fines. 1. For bad workmanship. 2. For absence from work without permission. 3. For infraction of the works' private rules for maintaining order therein. For no other causes, of whatever nature, may fines be levied."

Fines have to be entered in the workmen's wage books within three days, and the sum is deducted from their wages at the next pay day. There are definitions to this statute, specifying for what acts the fines may be made; the sums have also to be entered in a special official book for the purpose, and when the aggregate sum of fines held by the cashier is above £10, such sum must be placed to a special account in the nearest branch of the Imperial bank. From this account sums are granted by factory inspectors to workmen making proper application, who may have suffered losses by fire, sickness, etc., or widows or children may receive assistance therefrom, in cases of death of workmen. Naturally such payments are made only to workmen or relatives of workmen, belonging to works whose fine account has a balance for the purpose. If the money paid in by a works has been all distributed, such applicants cannot receive assistance from the general account, for all works in Russia. That is to say, workmen serving at one works cannot be assisted from money paid in to the fines capital account by another works. There are, of course, any number of legal statutes besides the foregoing, relative to conduct of factories and works in Russia. These, though severe and comprehensive in their scope, are not of a nature generally to cause serious disputes between employer and employee.

COMPENSATION FOR INJURIES

The existing Russian law of compensation for injuries by accident to work people was introduced in the year 1903, and from the way its provisions have been drafted, it bears in an exceptionally heavy manner on all employers of labor. Correctly enough, there is no possibility of workmen contracting out of it, neither is there, in like manner for any employer doing so, relative to sub-contracts; neither is there any clause relative to what, in other countries, is known as contributory negligence.

To give all the provisions of this law would occupy too much space; it must here suffice to give a few of its main provisions and failings. By it, each and every case of bodily injury, however minute, the merest scratch or bruise, must, if a workman complains that such does not allow of his properly following his employment for a period of *above three days*, be reported within the three days to the nearest police office, and also to the factory inspector for the district in which such injury has occurred, and the employer must pay the workman during the period of incapacity, if temporary, and above the specified three days, one-half of the average daily earnings of the injured. That is to say, not one-half wages at rate per hour, day or week, but one-half of what he earns on an average, if he is a piece worker, which is quite another matter. Should the injured be totally incapacitated, then the employer must pay him a yearly pension of two-thirds of his former average earnings, and this for life. Any case of permanent *partial* disablement, for instance loss of a finger joint, finger, hand, etc., is rated at a percentage of the total loss, and the yearly pension based on this percentage. In the case of young persons being injured, their pensions, as above, are periodically increased up to full manhood age, such increased pensions being regulated by a definite provision of the act.

In cases where death follows an accident, the relatives dependent on the deceased, and specified in the act, receive compensation along the foregoing lines.

In cases of partial disablement by injury, the sums payable on the foregoing basis may be commuted by payment of a lump sum, generally reckoned as a 10 years' aggregate of the sums that would be paid in pensions for that period. That is to say, if a yearly pension would amount to say five pounds, a sum of fifty pounds would be paid to commute this, and end the matter. Should it, however, happen that within a period of three years the original injury develops symptoms that still further incapacitate the injured, the latter has the right to reopen the case and seek further compensation.

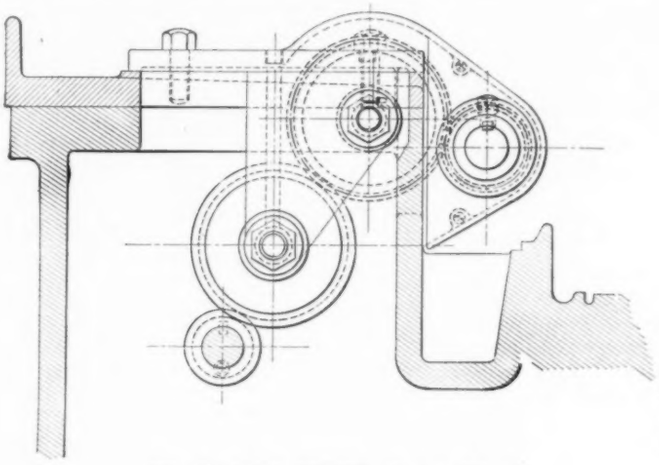


FIG. 6. CROSS SECTION AT A A FIG. 5

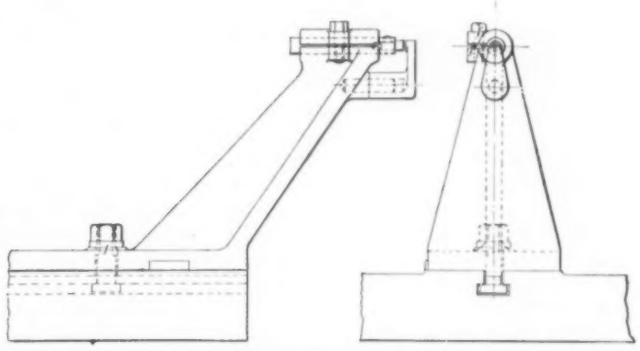


FIG. 7. DIAMOND HOLDER

FEATURES UNJUST TO EMPLOYERS

It is not the place here to give the whole of this very comprehensive Russian law of compensation for injury to work people. There are three points embraced by the law that render it specially overbearing on all employers of labor in Russia. The first of these is undoubtedly the want of definition of the term gross carelessness. The absence of this definition is an unaccountable oversight; for, although the general factory laws prohibit a workman from cleaning machinery in motion, yet it is certain that if a firm took exception to paying compensation for an injury caused through this, and the case went into court, the decision would be that such did not consist of gross carelessness within the meaning of the act, *or it would have been specified in the statute relative thereto.* Any number of similar circumstances might be put forward, such as interfering with machinery to which a workman or person has neither need nor right of ac-

cess, larking, practical joking, and so on, being in parts of a works where the workman has no occasion to be, unless definitely instructed by someone in charge, and there being injured, and many other like circumstances. The second point of complaint is the absence of protection against malingering on the part of badly disposed work people.

MALINGERING CASES

Any number of such cases occur, and there are no sensible provisions in the act for dealing with them. For instance, a workman or lad injures himself in a street row or at home, and the very next time he is in the works, he comes with his injury; a casting or other heavy article has fallen on his foot or leg, or he has run a splinter of wood into his arm, or broken his finger and he brings his witnesses thereto. Well, one has to pay—there is no other remedy except going to law. If in the provision of law of compensation there was a distinct instruction to employers to refuse under penalty to pay men who bring doubtful claims forward, lay the onus of proof in such case on the workman, and make him pay a heavy penalty, and his witnesses, too, for failing to prove that he received his injury while actually at work for his employer, then these many cases of false claim and malingering would cease.

In malingering cases, too, to show that an injury is far worse than it really is, and so get a lazy time on half pay, or enhanced compensation, as frequently occurs, there is no safeguard or definite declaration relative to medical opinion that should be conclusive. In fact, the only way is to go to court, and this may mean days or weeks of waiting and appeal afterward, involving several more weeks, during all of which time the firm must pay the man half wages to sit at home and nurse his crooked and bandaged finger or leg, which is probably in as sound a condition as it was before the small injury which is supposed to have caused this malformation. This leaves out of the question the incidental expenses of attendances at court and waste of time in the office over the wretched affair. Had the statutes included one laying down that a commission of two of three doctors—the one chosen by the workman, the one chosen by the firm and the third a city or army doctor appointed by the factory inspection council—should definitely pass upon each suspected case of malingering, the thing would very soon cease.

A similar provision should have been made for settling minor injuries, relative to the actual percentage of incapacity to the injured; frequently a hardened tendon or some similar thing occurs, for which 5 per cent. or 10 per cent. incapacity is given, while in reality not one bit of incapacity actually exists and the man injured earns the same piece-work rate as before.

PROVISIONS AS TO CONTRACTORS' EMPLOYEES

The third point where this law bears hard on employers relates to contract work: for instance if a new works is being built on adjoining land or a works is being enlarged and the work therefor is let to a contractor, any person in that contractor's employ has to be compensated if injured, not by the contractor, but by the owners of the works employing that contractor. The principle here is utterly wrong, for why should the owner be responsible for workmen not engaged by him for his direct profit; workmen under supervision for which he is not responsible, or for tackle and appliances neither used by nor owned by him? Naturally an owner of a works employing a contractor makes a legal and abiding agreement with him, whereby the contractor must repay to the owner any money paid by the latter for claims for injury to the contractor's men. On paper this looks all right, but should that contractor repudiate his liability it means a long, tedious and expensive lawsuit and should the contractor go bankrupt, out of business or die, leaving no assets, why, the owner of the property has to pay money out of his own pocket for injuries to men not employed by him, and who have no connection whatever with his business.

OTHER UNSATISFACTORY FEATURES

There are one or two other unsatisfactory points in this law: For instance men may be injured, receive an award of, say, 20 per cent. incapacity for which they get their yearly life pension. They can then engage with another employer at a higher salary than before they received their injury in the works of their former employer, who must go on paying the pension. If the former employer within the three years allowed objected to paying on the ground that the man was receiving more pay in his new employment, the man would say, "Yes, but had I not been injured with you the wage I now receive would be still more, and I now, as it is, demand that the sum paid in pension be increased to suit my increased wages." And as the law stands he would be perfectly justified, legally, and probably win his case if he brought it into court.

On the whole, this law of compensation for injury as it exists today in Russia is very unsatisfactory and if, as it may be later, it is used by employers against the work people, may well cause no end of strife. Possibly employers will make it a rule to discharge all work people compensated, on the ground that their injuries render them of no further use, and they may also, perhaps, when they form their federation, circulate lists of such injured persons and so keep them from earning higher wages, or even worse; sooner or later something of the sort is sure to happen. This law seems especially formed, from its indefiniteness on the points mentioned, to make bitter strife between employer and employed, rather than to so regulate matters that all bitterness in disputes as to compensation should be avoided.

EFFECT OF RECENT DISTURBANCES

Having shown briefly the relations between employers and employees so far as the factory act and law of compensation for injury relate directly, it may be well to consider in as concise a manner as possible what effect upon these relations all the recent strikes and political disturbances have had. It may be summed up by one word applicable equally to both parties, "disastrous." Disastrous to those employers who have systematically treated their men with severity, on parlous poor pay; disastrous to employers who had hitherto treated their men well and where the latter earned good wages; disastrous to all friendliness and an all-around give-and-take accommodation to economic conditions as between employer and employee; disastrous to the workmen of the better class who would gladly work peaceably and improve their condition in a legitimate manner; and above all disastrous, incalculably, to the younger generation now growing to manhood and the still younger generation but now entering on their first experiences of workshop life. The disastrous effect on all social life, law and order in Russia generally, but with which we have little to say here, only those who have lived through it the past few short months and kept their eyes and ears of understanding open, can realize. Although a propaganda has been at work among the working population for years, having in view the ultimate revolt of this class of the population against the grinding conditions of their lives, it needed the military and naval disasters in the late war, with all their accompanying horrors, mismanagement and pecuniary misappropriations, to bring such secret workings to a head and wake to life the voice of the working masses. Had there been no war, matters would have drifted along smoothly as before, with the undercurrent occasionally breaking out at different places and in different ways; had the war been a success or a series of victories for Russian arms, there is no doubt but that the emancipation of the working classes in Russia would have been postponed for many years; had the war been won victoriously by Russia, it would have been hailed with acclamation by the whole people and the system of government held up to the world as the only system that could bring such results. It was not to be, and we all know what has happened instead.

ECONOMIC STRIKES

The first troubles that occurred were the so called economic strikes of work men against their conditions of employment generally, and they succeeded in obtaining their demands almost everywhere.

The strikes generally were carried out in an orderly manner, the deputations of workmen to employers were received in a courteous and fair spirit, the details of the demands the men's representatives put forward were discussed in seriatim and at exhaustive length, and there is no doubt that very few demands that were really sensible and just were refused, and a regular system of delegates in most works was established who, in the future, were to be the medium for bringing before and settling with employers all disputes as to wages, hygienic conditions and general rules regulating work and employment. The first mistake the workmen made was to demand *executive* power for these deputies or delegates; that is, right to take on or discharge not only workmen, but also foremen and even managers and directors. This point was not granted, and the refusal rankled. Needless to say, in the present state of skill, knowledge of commercial affairs and general lack of even rudimentary education of the Russian work people to have granted such a demand would have not only been suicidal for employers, but against the workmen's own interests, though quite possibly it would be a vain thing to attempt to convince them of this, even now.

Having gained their victory, it might have been expected that the work people would have had the common sense to set about making their new position secure and unassailable; and had they done so, in a legitimate manner, the authorities would have lent all their strength and assistance to that end. No interference at the first strikes in February, 1905, was made with the workmen by the authorities, except to keep the peace, they declaring officially that they would make it none of their business to settle peaceably conducted disputes between employer and employed. Here, unfortunately for themselves, the workmen made their second mistake, or more probably they were openly led into it by those unseen wire-pullers who had other ulterior views.

POLITICAL STRIKES

Instead of consolidating their success relative to their bettered working conditions, and organizing to still further better themselves, they must needs allow themselves to be urged on to political triumphs to be, that were to turn the whole Russian Government and authorities into the street, and then they would step in and boss for themselves. This ended in the great political strike in November and December, 1905, of railways, post and telegraphs, and all works and workers, universities, high schools and even infant schools, followed by armed rebellion in many places. The result immediately was the crushing of the rebellion and discharge of practically every man, woman and child from their employments, thousands of arrests, murders and maimings, and out of this chaos armed repression, the strength of which has been growing until at the present moment practically all Russia is in a state of war, with drumhead courts martial making short shrift with all persons that come under their judgments.

RESULTS OF ARMED REBELLION

So far as the working classes are concerned, the results of the fiasco of armed rebellion have been to place them in a wretched condition. In very many cases large works have been closed down altogether; others have since been working with a greatly reduced force of operatives; hundreds of little places have gone forever, and all, without exception, are suffering from lost and disturbed trade, the revival of and putting to rights of which has taken months, and may yet take years before something like their former prosperity will again exist; but by far the most serious matter for the work people has been the sweeping away at one blow, and by their own self-chosen act (the armed rebellion) of all the privileges and acknowledgment of their rights which they so successfully won for themselves at their first strike in February, 1905; all delegates have been abolished, no meetings are allowed, everywhere factory rules and regulations have been made more severe, and a feeling of despondency at their utter helplessness created. All confidence between employers and their men seems destroyed, and it will be long before a better feeling in general will arise. The slightest attempt at a strike has its sequel in arrests and imprisonments, and employers and their managers are expected to inform the police immediately upon the slightest sign of unrest among workmen. At the moment, managers and foremen stand in a position between "the devil and the deep blue sea." If they omit to give information to the authorities on this, that or the other, they are in trouble there, and if they do give such information, and it is brought home to them, their days are ended with a shot from round some corner of the shop, or other less pleasant form of despatch. Of course, the bullet and the bomb must fall from the clouds, as nobody knows anything about them, and "the person unknown" is the last one hears of the matter. Such crimes are generally committed by boys of 16 or 17.

PRESENT STATUS OF THE WORKMAN

All this is very sad; doubly sad for the poor workmen who now know no peace, have no rights and have no work. Those that have employment make subscriptions to help those out of work; but even these subscription lists have to be made up secretly very often, to avoid seizure which, if it occurs, means forfeiture of the money as well.

It is a thousand pities that the workmen have mixed up politics, of which they know so little, with their work-life needs, of which they know so much. It undoubtedly has not been their fault as a body, only in so far as they allowed themselves to be led by their unseen and unknown dictators to believe that, *armed*, they would be invincible. Not long since the *Engineer*, of London, had a leading article on French trade organizations, which have for 25 years followed the—for workmen—fatal policy of making their organizations politico-economic, and have made no headway through the jumble, comparing this with trade unionism in England, which mainly aimed at raising the status of its members, to which aim politics were left for later and generally separate considerations.

For how long matters in Russia will remain as they are today, no one can promise; but it would have been better both for employers and employed, if the two were left to balance matters between themselves, for it is far better to have such conflicts open and above ground, and fought out with as much good feeling on both sides as possible, and on lines of common sense both from the commercial and status betterment points of view.

MORE ENGINEERING WORKS NEEDED

In spite of everything which may be urged to the contrary, such as dislocation of trade, outrages, strikes and the general topsyturvydom all around, there is any amount of need for more engineering works in Russia, all of which, if well equipped and honestly managed and arranged to supply the specialties as demanded in different districts, would earn good dividends. There would be plenty of uphill work the first two or three years, but afterward the returns would be excellent. The main thing is sufficient capital for working after a works is built and equipped. More of such capital is necessary, owing to the long credit system of working, than is usually the case elsewhere, and there need be no fear of serious losses by this system either, if ordinary precautions are taken. There are firms who practically do all their chief business on credit and sustain very few losses; indeed they gain, as is only right, an extra profit therefrom, as interest is charged on the outstanding sums and paid too.

It is quite possible, indeed highly probable, that in the near future import duties on all classes of machinery and other goods will be raised considerably, which will also be an extra inducement to introduce fresh capital into engineering business in Russia. The labor, as has been shown, is not of the best, but by judicious selection and weeding out, very good bodies of men may be collected, who, if they are only treated as *men*, and with common sense, will surely improve in spite of all drawbacks.

The future for such enterprises in Russia may look black, but it is not so in reality and it would be utterly wrong to judge that future by the late upheaval and the seeming chaos at present existing. The

tremendous storm will surely pass over and a brighter period ensue, when each and every one, employer and employee alike, who can work and will work, will reap increasing benefit from their energies.

Russia.

An Engine Erectors' Line Adjuster

EDITORIAL CORRESPONDENCE

The accompanying illustrations show an implement for engine erectors' use both in the shop and field. It is of Canadian origin, and has been used to some extent in Canada, and is of such obvious utility as to deserve wider publicity and use than it enjoys.

It is not necessary to do more than to refer to the clumsiness and awkwardness of the usual lack of method of setting center lines, which is a trial to the patience and a disturber of the temper to an extent that leads one to wonder that something similar to the device illustrated did not make its appearance long ago.

Fig. 1 shows in plan a pair of lines adjusted parallel and level for the erection of the engine about them. The adjuster is indicated at *a a a a* mounted on substantial supports, and is shown in detail in Fig. 2. The line passes through a hole in the center of the adjustable screwed rod *b* which is mounted in the frame *c*, the frame being adjustable vertically in the base casting *d* by the screw *e* and thumb nuts *f*. The base castings are secured to their supports by screws passing through the holes *g*, each one having a hole *h* through it of an inch and a quarter diameter, giving ample opportunity to adjust the lines after the bases are secured roughly in position. In setting the lines it is of course necessary that their ends be truly level with one another, and that they be parallel and at a proper distance apart. Truth as regards level is secured by placing a straight-edge on the shelf *i*, which is at the same distance above the line in all the instruments of a set, and then applying a spirit level to the top of the straight-edge. Truth as regards parallelism is secured by applying a length-stick between the opposing hardened ends of the rods *b* which, being of equal length and having their line holes in their exact centers, insures true parallelism of the lines when their distances apart agree. The thumb nuts will be seen to be arranged to act as jamb nuts, and thus permit locking the lines in position once the adjustment is complete. The line will be seen to pass over an elongated pulley *j* and to be held taut by a weight *k*.

The instrument is the invention of A. S. Hamilton, of Nanaimo, B. C., Canada, and is patented in the United States and Canada. F. A. H.

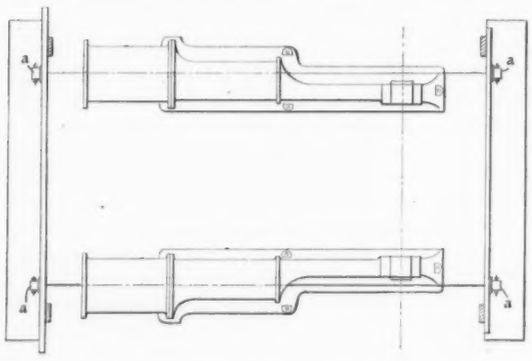


FIG. 1. LINE ADJUSTER IN USE

Echoes from the Oil Country—A Loafing Job around a Creamery — Separators, Line Shafting, and Couplings

BY W. OSBORNE

When a man has loafed around a creamery at odd times for days, and drunk unlimited quantities of buttermilk without cost, and minutely examined the separator both when it was running and when it was apart for cleaning, and has been pointed out as a machinist who is not as insignificant as he looks in his old loafing clothes and borrowed straw hat, he does not like to shy at the first mechanical proposition that comes his way, even if he has come out to be away from the shop for a time.

Musing over the way that the cream was separated from the milk could hardly be called work, and neither could admiring the silent way the separators ran at the very high rate of speed used to do the work be so classed, and the opening remarks of the proprietor also seemed far away from it, as far as I was concerned.

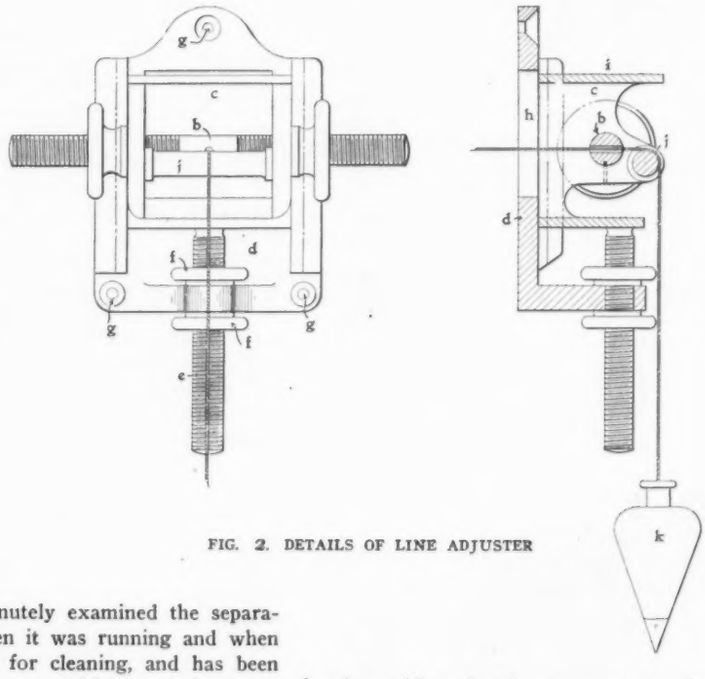


FIG. 2. DETAILS OF LINE ADJUSTER

A COUPLING QUERY

"What kind of a coupling do you think best to fasten two shafts together?"

Knowing that a man who makes too positive statements of his opinions has a harder time of it trying to shift his position gracefully than the man who does not, I tried not to commit myself as I replied: "It depends very much on conditions. Some are good in one place and some in another. The cost has to be considered, too."

"That is the place right up there. We cannot hold those shafts together. The one on the end should run the churn and the water pump, but it keeps working loose. We put in another set screw on each end and then had the blacksmith cut a keyway and put in a key, and the four set screws and the two keys do not hold it for more than a few days at a time. Maybe the work is too hard for a clutch. That churn gives quite a jerk when 300 pounds of butter begin to drop from one side to the other." He gave a resigned sigh, as though he really felt the case was beyond ordinary skill.

I thought of the little engine, which was just a little bit bigger than a jobbing hand would undertake to carry to the shop on his back, and began to get interested. It did not seem to have power enough to do anything very desperate with a coupling. I wanted to see the coupling, and found it to be a short-sleeve coupling that was chewed up quite badly, and so was the end of one of the shafts. The end of the other one was not so bad.

"All you need is another coupling about 4 inches longer than this one. It should have four set screws and a keyway, and if it is put on right it will never come off."

"I don't want to bother your vacation,

but I do want to get that fixed. If you will just tell me what to get, I will get it, and if a wet day should come, perhaps you could find time to show us how to put it on."

GETTING DATA FOR THE NEW COUPLING

When a man is not doing anything but killing time he should be willing to kill some of it in the interest of the man who has made it pleasant for his family, and gone fishing with him, and lent him fishing tackle, and fire wood, and a horse, and then it was like old times to do a job without the tools, and I did not bring even a rule along. I started in. My friend had a ruler such as are given away, with an advertisement on one side and some marks supposed to be inches and quarters on the other. He also had a small blacksmith shop where horseshoeing was done. I got a file there. A piece of wire made a pair of outside calipers. I finally got a good "feel," but took quite a little time doing the setting to get it. A nail made a very good gage. It was fitted to the wire calipers. That shaft, as near as I could guess at it with the help of the measuring stick, was one and eleven sixteenths. The free-hand sketch that went with the gage showed the set screws about two inches from the ends. They were set ninety degrees apart, and the keyway was between them. The coupling was ten inches long and a square piece of iron the size of the keyway was to form the key. It was then time to dig bait.

FITTING THE COUPLING IN PLACE

Two days afterward the coupling was at hand and so was a rain. I had to do something to amuse myself, and as soon as the machinery stopped I began by filing the burs off the shafts and trying the coupling on. It took driving with a hatchet to get it on and off. I made a cape chisel out of a short piece of an old one at the blacksmith shop, and after laying out a line with the point of my jackknife started in on the keyways in the shafts. An old lantern furnished the illumination. The coupling came close to one hanger and this piece of shaft was rigid enough, even if it did have a bad habit of working endways. The other shaft was so far overhanging that it was very springy, and made the work slow. The temperature up there was entirely too high for comfort, and helped me to the conclusion that it was easier to dress the key down than it was to cut the keyways to a depth equal to half the width. The square iron was left in one piece and each end forged down to the size of the wooden key that had been made for a gage, and after a little fitting things were ready to go together. It took some driving with the head of an ax to persuade the parts to go together, and I did not forget to drive on the heads of the set screws so as to get a good bite on the shafts. I was not afraid of that coupling letting go for a little while unless the engine got stronger, but I knew that the shaft was badly out of line.

Though I wanted the shaft to be in line it had stopped raining, and I felt sure that the fish would bite good, so I decided to turn the balance of the job over to the proprietor and the buttermaker who had both been watching me work. I had been watching them before this job came along. They looked rather doubtful when I told them that they could line that shafting as well as I could.

A LESSON IN THE ART OF LINING SHAFTING

"All you need is a fishing line, three nails, three sticks, and a little knowhow. I will furnish you with the latter. Take one of the longest sticks and nail it on the joist beyond the end of the shaft and about a foot and a half to one side. Only use one nail. Do the same thing with another piece at the other end. Stretch the line from one to the other. Make it as nearly level with the shaft as you can see by sighting over the shaft. If it is a little high or a little low it does not make any difference just so it is the same all along. Drive your other nail into your remaining stick so that it is about eighteen inches from the end." I whittled the end of that stick to a point. "Lay the stick on the shaft there at the end. Let the nail touch the shaft and move the stick that holds the line so that the line will touch the point of the stick. You can move it in or out as you need to. That is why I had you use one nail. Now one of you get up at the bearing nearest to the coupling while the other one goes to the other end and moves the stick so that the line is right at the bearing. Now if you will take the stick and try the other end of the shaft you will see why that old coupling used to work loose." It was about five inches out of line. Looking at it from the floor it did not appear to be level either.

"You may as well hunt up a brace and some bits and a wrench or two, for some of those hangers will have to be moved, and while you are at it I would advise you to get a level and go over the shaft with it. Never mind about getting it too level, but get it the same all along. Your bolts might not be long enough to take in enough packing if the building is out of level. Mind that the idea is to get it in a straight line each way." I went fishing after that with a clear conscience and they finished the job in good shape.

CREAM SEPARATORS AND MATERIAL FOR MILK CANS

While hanging around watching the teams drive up with their loads of milk cans I have thought of the far-reaching effects of the invention of the separator. I suppose that all mechanics know that a separator is a machine that is fed fresh milk which it separates into skimmed milk and cream. The same team that brings the milk can take back the skimmed milk.

Centrifugal force is not anything new, and yet most of us would not think of using it to skim milk. Seeing those loads of cans made me think of the changes that this invention brought with it. Factories had to make the cans and perhaps you and I had to wait for our sheets because the mills were too busy supplying the can factories to get to us. That may have been the reason that the prices went up too, and we were blaming it on the salesman.

I do not have any idea as to the amount of material that is worked into milk cans, but judging from what I saw in that section it must be enormous, for a creamery could be found every few miles in every direction, and besides the regular cans used for shipping milk had to be provided. Probably the machinist who has worked on separators has never thought that those same machines had a tendency to make at least a temporary shortage in the needed supply of sheets such as are used to make heavy cans.

In this creamery was one separator that was run with an impact steam turbine, or as one farmer expressed it, "It has a steam water wheel down in the bottom of it." There did not appear to be any particular refinement about it, but for all that it did its work well and was liked.

When questioned the proprietor said, "I can't say just how it compares with the other one for the amount of steam it takes to run it. I know it does not take any more, but it is so much handier that I would rather have it even if it did. Nothing to fuss with, but just turn on the steam and let it go." Perhaps the next time I get back there I will find the churn and the butter maker each run with a turbine unless the gas or gasolene engine gets there first.

It seems that the foreign sellers of alleged wonderful steels have been working among the lumber men of the country and have made victims of a considerable number of them. The *American Lumberman* has been cautioning its readers regarding this business, and it will be remembered that some months ago we called attention to it, and advised our readers to be very careful in giving orders for wonderful tool steel supposed to come from France, or any other foreign country, and especially to avoid paying for such steel until it had been clearly shown to be as represented.

The statement is made that the wages of employees of the Pennsylvania Railroad have been increased to an amount which will equal a total of $702,952 per month, or nearly eight and one-half millions a year. This is an increase of about 10 per cent. Some branches of the Standard Oil industries have also increased wages considerable.

WORM CONTACT—II*

The Nature and Limitations of Tooth Contact—Some Experiments Relating to Worm-gears

BY ROBERT A. BRUCE

In Fig. 19 the lines of contact are drawn for a worm whose acting face is generated by the line *aa*, which rotates and advances along the axis at the rate of 18 inches for one complete turn. The pitch plane is situated 3 inches from the axis and the inclination of *aa* to the axis is 15 degrees. The surface generated therefore is that of a right-hand worm whose pitch is three times the pitch diameter. The lines *bb*, *cc*, *dd*, *ee*, *ff*, and *gg* are sections of the worm surface by planes whose traces are *AA*, *BB*, *CC*, *DD*, *EE*, *FF*, and *GG* in the transverse section. The corresponding lines of contact are $a_1 a_1$, $b_1 b_1$, $c_1 c_1$, $d_1 d_1$, $e_1 e_1$, $f_1 f_1$, and $g_1 g_1$, which are the sections of the surface of contact by the planes of sections *AA*, *BB*, etc. (In this and all other figures giving the surface of contact the sections of the acting face of the worm and the contact paths have been obtained by calculations, using the formula in Appendix I.†) The surface is seen to be twisted. All sections of the contact surface cut the line *PP* whose trace in the longitudinal section is *p*. It will be seen that there are no real lines of contact corresponding to sections of the worm surface *cc* and *dd* by planes *CC* and *DD*. The dotted lines $d_1 d_1$ and $c_1 c_1$ represent imaginary contact lines fulfilling the mathematical conditions of contact only, physical contact being prevented by interference. There are real contact paths beyond the regions of the diagram corresponding to the sections *dd* and *cc*, but they are at such a distance to the left of the diagram that in conditions likely to arise in practice they may be ignored.

The contact surface of the Fig. 19 is typical of the contact surfaces common to all very "steep-pitched" worms where the helical angle at the pitch line approaches 45 degrees (the angle in this case being 43—50 degrees). Certain peculiarities should be noticed. The useful or effective portion of the contact surface is much more extended transversely, on the side to the left of *AA* in the transverse section, or behind the central plane in the longitudinal section. On the other hand, the inclination of the contact line on this side is greater as the distance from the central plane is increased. The inclination of $g_1 g_1$ at the commencement of contact is very marked, while that of the line $b_1 b_1$ denotes a considerably reduced obliquity. In Fig. 20 the scheme of lettering is the same as in Fig. 19, the worm represented in this case being one whose pitch is equal to the pitch diameter, the helical angle being 16—42 degrees.

Fig. 20a represents the sections of profiles and contact surface of a worm of the same diameter, the pitch being reduced to 2 inches and the helical angle being 6 degrees 4 minutes. The distortion of the contact surface is much less marked, and as the ratio of pitch to pitch diameter (as in Fig. 20a) becomes less and less the tendency of the surface to coincide with an oblique plane whose trace is $a_1 a_1$ becomes greater and greater.

The limitation of the contact surface to the left of *AA* is not here so apparent, but the tendency toward greater obliquity on that side of the worm which, as it rotates, is advancing toward the central plane is still marked, though not to the extent indicated in Fig. 19. In conjunction with the foregoing remarks, Figs. 19, 20, and 20a sufficiently indicate the general tendency of the surface of contact for any given worm, but the actual amount of contact depends upon the limitations imposed by interference or by the intersections of the surfaces bounding the two gears with the contact surface.

ILLUSTRATING ACTUAL BOUNDARIES OF CONTACT SURFACE.

Fig. 21 is drawn to scale to illustrate the actual boundaries of the contact surface in the case of right-hand worm 8 inches diameter, 8 inches pitch (double thread), gearing with a worm-wheel with 30 teeth. The lettering is similar in all three views of the contact surface, the boundary of which is KOK^1O—the dotted lines aA, a^1A^1, etc., represent lines of contact in planes parallel with the central plane (that is, dividing the worm-wheel symmetrically and containing the axis of the worm). It will be readily seen that the lines of contact are much more extended on the side of the contact surface where the worm-wheel teeth are receding from the central plane (that is, on the lower side in plan), and that the average obliquity of contact is at the same time less on that side. It must not, however, be imagined on this account that the receding side of the contact surface is the more valuable, for in determining the ability of the surfaces in contact to transmit pressure without undue wear or abrasion, it is necessary to consider the mutual forms of the surfaces in contact as well as the length over which contact is maintained. The actual contact at any moment takes place along a curved line which is the intersection of two surfaces, namely, the acting surface of the worm and the surface of contact. Thus, in Fig. 21, the line *QQ* in the transverse section of the worm shows the line of contact across

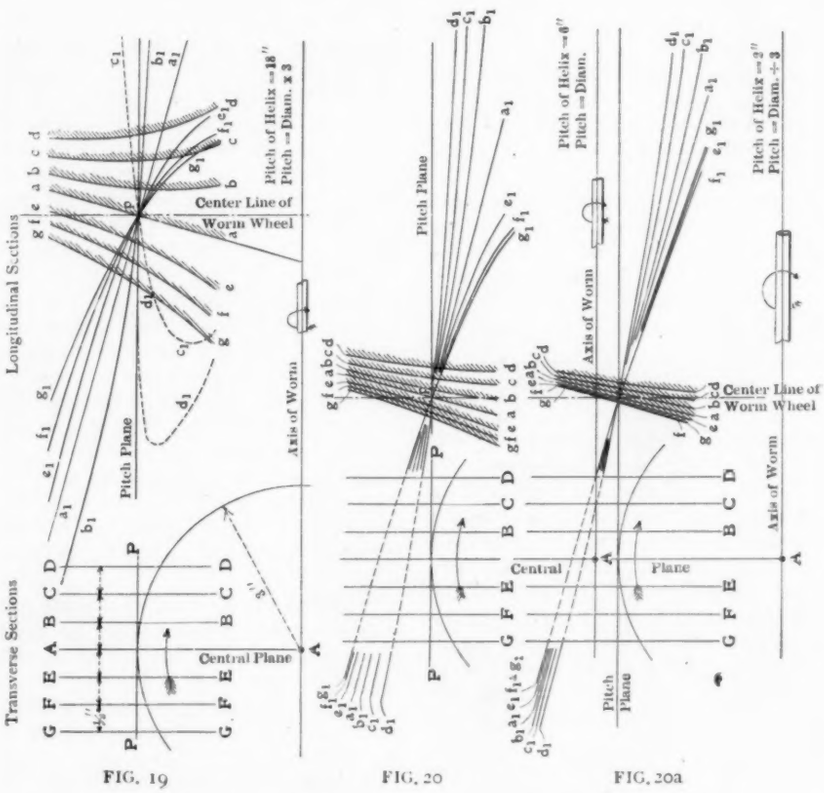


FIG. 19 FIG. 20 FIG. 20a

PLANE SECTIONS OF CONTACT SURFACE FOR VARIOUS RATIOS OF PITCH TO DIAMETER

*A paper read before the British Institution of Mechanical Engineers.

†The appendices are omitted here.—Ed.

the face of the worm at the moment when contact takes place at the pitch point. Mathematically, contact along a line yields no area, but it is scarcely necessary to state that the elasticity of the surfaces and the viscosity of the lubricant in conjunction contribute to expand this ideal line contact into contact over an area on either side of this line.

INFLUENCE OF CURVATURE OF PROFILES IN CONTACT.

The relative curvature of the surfaces in contact must therefore be carefully considered, for it is obvious that if they have opposite curvatures, as is the case with surfaces mutually convex, the area of physical contact will be much less than is the case where the curvatures are in the same direction, as happens when a concave touches a convex surface. The influence of the curvature of profiles in contact is illustrated in Figs. 22 and 23, which represent various positions of the profiles of the worm and wheel of Fig. 21, the planes of section being symmetrically chosen with reference to the central plane. The contact along *d D* in Fig. 22, though much less extended than that along $d^1 D^1$ in Fig. 23, is of a kind much more adapted to withstand heavy pressures, the convex profile of the worm-wheel fitting into the concave profile of the worm in Fig. 22, whereas in Fig. 23 the opposite curvatures of the profile are less suited for retaining the oil-film upon which the power of sustaining a load depends. Generally speaking, on the side of the central plane where the worm is advancing, the curvature of the profiles is alike though the path of contact is less extended, while on the side of the central plane where the worm is receding the contact path is more extended and the curvature of the profile is unlike. It follows, therefore, that the mere extension of the contact surface of a worm and worm-wheel is insufficient in itself to determine the amount of end pressure which can be safely sustained at any given speed, the curvatures of the various sections of the surfaces in contact playing an important part. The ability of any given worm-gear to withstand wear depends upon the maintenance of an oil- or grease-film between the surfaces in contact. As the tooth of a worm-wheel passes through all the phases of its contact with the worm-thread, the line of contact traverses across its face, and is therefore continually passing across portions of the worm which, since being in contact with the preceding worm-wheel tooth, should, in a well lubricated system, have been freshly lubricated. The rate of transference of the line of contact over the tooth face in conjunction with the tangential rubbing velocity is therefore a factor of prime importance. The width of the contact line or its dimensions across the face of the teeth and its effective breadth are factors of equal importance.

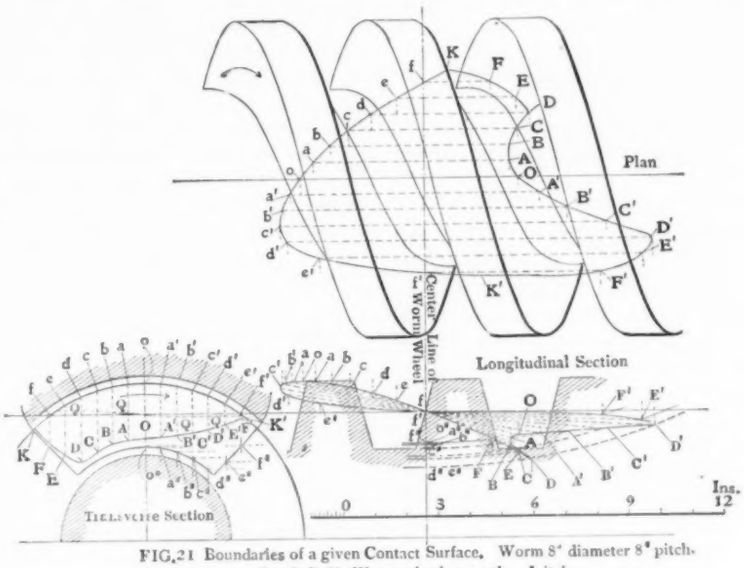


FIG. 21 Boundaries of a given Contact Surface. Worm 8" diameter 8" pitch. 2 Leads R.H. Worm-wheel 30 teeth. 4" pitch.

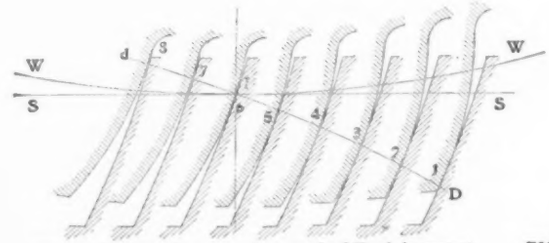


FIG. 22 Sections of worm and worm-wheel Teeth in contact by plane d D on advancing side of worm.

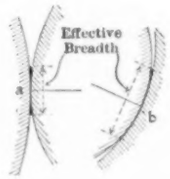


FIG. 24 Influence of Curvature on Effective Breadth of Contact Film.

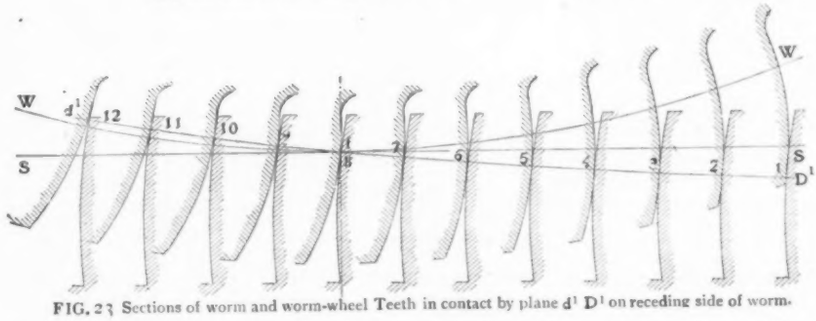


FIG. 23 Sections of worm and worm-wheel Teeth in contact by plane d^1 D^1 on receding side of worm.

ESTIMATING THE EFFECTIVE BREADTH.

By "effective breadth" the dimension parallel to planes of section is meant, see Fig. 24. The "effective breadth" is indeterminable, but a comparative estimate can be formed of it by considering the curvature of the surfaces at any section. Thus, in Fig. 24, it is obvious that a much greater load would be sustained by a surface such as is illustrated at *a* than by surface such as *b*. In Appendix II reasons are given for taking the quantity $K\sqrt{\frac{r_1 r_2}{r_1 \pm r_2}}$ as a measure of the effective breadth, where r_1 and r_2 are the radii of curvature of the surfaces at the point of contact. According to this view the effective breadth is proportional to the square root of the product of the radii divided by the square root of their sum or difference according as the curvatures are opposite or alike. In Appendix III an expression is given for this measure of the effective breadth when contact occurs at the pitch plane, and it is sufficiently near the truth to take this value as an average value for

v	μ
3	0.086
5	0.078
10	0.064
20	0.050
50	0.035
100	0.025
200	0.018

v = rubbing velocity in feet per minute (reckoned as circumferential velocity of worm at pitch diameter).
μ = coefficient of friction, cast iron on cast iron lubricated with lard oil.

TABLE I.

any particular section. Table 3 has been prepared giving the values for the "effective breadth" of the sections of Figs. 19, 20 and 20a. Broadly speaking, the result of the calculations summarized in Table 3 is that, for worm-wheel drives of similar general proportions as to hight of teeth and arc of worm embraced by the worm-wheel (in transverse section), the average "effective breadth" of the contact line varies very slightly on account of variations in the ratio of thread pitch to diameter of worm. On the other hand, the effect of increase in diameter of the worm-wheel has a markedly beneficial effect in this respect, the effective breadth varying as the square root of the diameter of the worm-wheel. The average width of the contact line across the face of the teeth will vary directly as the diameter of the worm, the slight diminution in width when the ratio of thread pitch to diameter is high being nearly balanced by the tendency toward greater "effective breadth."

Therefore, to sum up, the area of physical contact varies as the pitch diameter of the worm multiplied by the square root of the diameter of the wheel; or, if the effects of varying the angle subtended by the pitch line of the worm-wheel at the center of the worm be considered, it may be said that the effective area of contact varies as the continued product of the diameter of the worm, the tangent of half the angle subtended by the worm-wheel,

Rubbing Velocity. Feet per Minute.	Limit to Rise of Temperature.		
	50° F.	75° F.	100° F.
	Values of K.		
100	111	151	182
200	81	112	144
300	62	92	121
400	48	77	107
600	29	57	85
800	15	43	71
1,000	4.6	32	60
1,200	..	25	52
1,400	..	18	46

Vâlues of K in formula $P = K\sqrt{D}\,d \tan.\frac{\beta}{2}$ deduced from the experiments of Bach and Roser. The conditions being:

Material—Soft-steel worm. Bronze worm-wheel.

Lubricant—Heavy cylinder oil.

Lubrication—Worm dipping in oil bath. Size of bath about three times volume of worm with proportionate cooling surface.

TABLE 2.

is, however, much more apparent than real. Except in the case of abnormally small worm-wheels, the length of the contact paths on the worm-wheel side of the pitch plane is unaffected by the size of the worm-wheel. On the other side, the contact lines most affected are those which are flattest, or which most nearly coincide with the pitch line. The actual variation in the number of teeth in gear at any one time is found on careful in-

teeth are enabled to operate simultaneously; but at the same time, in order to avoid interference, the teeth should be pitched as finely as is compatible with strength and allowance for wear. It should be noticed that in respect of the hight of the teeth the dictum given above is in direct opposition to the best practice with spur-gearing, where entirely different conditions are in force.

EFFECT OF ANGLE OF WORM-THREAD.

The effect of the angle of the worm-thread remains for consideration. As the ratio of pitch to the diameter of worm becomes greater, the thrust of the worm is borne on a surface of greater inclination and the actual pressure on the teeth is increased in the same ratio as the secant of the angular pitch. At the same time the width of the contact line across the face of the teeth is increased in the same ratio, so that the actual pressure per unit of width remains the same. It is not necessary, therefore, to take any account of the angle of the helix in making estimates of the "effective contact area." Under precisely similar conditions as to temperature, lubrication, nature of the surfaces in contact and rubbing velocities, it might reasonably be anticipated that the end thrust would be proportional to the effective area, and neglecting comparatively unimportant factors we may express the relation as follows:

$$P = K\sqrt{D}\;d \tan.\frac{\beta}{2}$$

where P = safe end pressure in lb.
d = diameter of worm at pitch line.
D = diameter of worm-wheel pitch line.
β = angle subtended by the worm-wheel at the axis of the worm.
K = a factor depending upon rubbing velocity, nature of the surfaces, temperature and nature of the lubricant, etc.

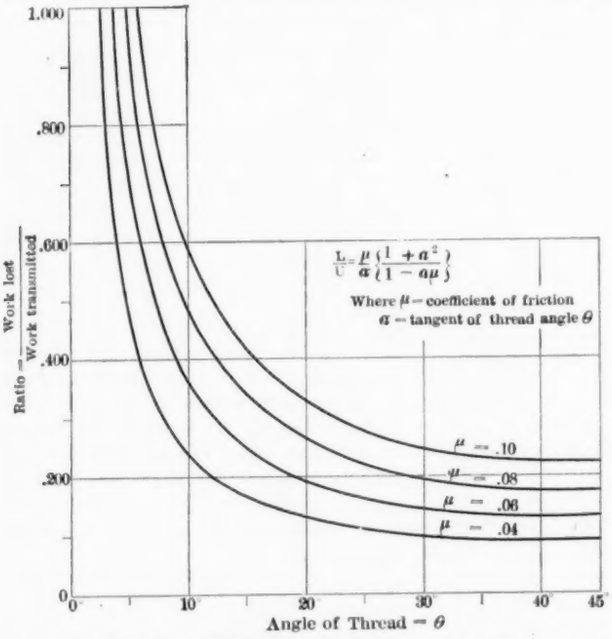


FIG. 25. RATIO OF ENERGY LOST IN HEAT TO WORK USEFULLY TRANSMITTED THROUGH WORM WHEEL

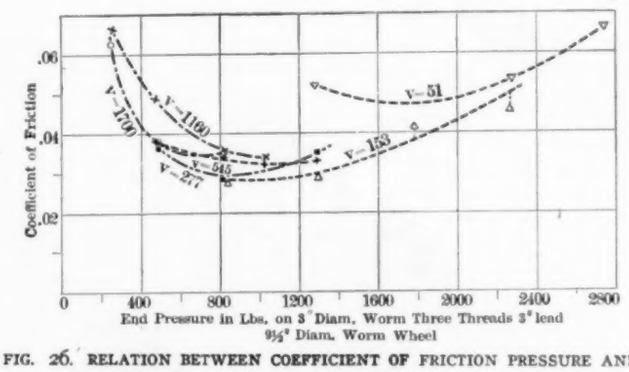


FIG. 26. RELATION BETWEEN COEFFICIENT OF FRICTION PRESSURE AND VELOCITY, DEDUCED FROM EXPERIMENTS OF BACH AND ROSER, v = VELOCITY IN FEET PER MINUTE

and the square root of the diameter of the worm-wheel. At any instant the end pressure is shared between several teeth, and it is therefore justifiable to expect a greater power of sustaining loads as the number of teeth in action is greater. The variation in the number of teeth in gear vestigation to be small for widely differing sizes of worm-wheel. So that in comparison with other more important matters it may be neglected.

By keeping the ratio of the hight to the thickness of the teeth as large as practicable, the greatest possible number of

Experience has shown that this relationship is far from simple in practice, because of the great difference in the factor K imposed by variable conditions. Broadly speaking, what happens in the case of a worm-wheel drive is very much what happens in the case of a loaded journal.

The action commences under certain conditions as to speed, temperature, and so forth, and as it proceeds heat is generated owing to frictional resistance, the amount depending upon the load, the lubricant and the efficiency of the gear. The temperature of the system rises until the heat generated by friction balances the heat lost by radiation and convection, when a stable set of conditions is established. But while the temperature is rising, the lubricant is losing its viscosity, and, though this tends to diminish the friction and consequently the generation of heat, it nevertheless diminishes the power of sustaining a heavy load. A worm will therefore be successful if the viscosity of the lubricant does not diminish to such an extent that its load-sustaining properties are neutralized. If the surfaces be allowed to come into grinding contact, further heating takes place, and the lubricant becomes still less viscous and therefore incapable of bearing a load, and seizing will take place quickly.

WORK WASTED IN HEAT.

The question as to how much of the work done in rotating the worm is converted by friction into heat, can only be answered when the pressure, the velocity, the angular pitch, and the coefficient of friction between the surfaces are all known.

Thus L = Lost work per minute = $Pv\mu \left\{ \frac{1 + a^2}{1 - a\mu} \right\}$ (See Table 2.)

where P = end thrust in lbs.

v = circumferential velocity of worm at pitch line in feet per minute.

a = tangent of angle of thread (θ).

μ = coefficient of friction.

The useful work performed in the same time is U where $U = Pva$.

So that the proportion of lost to useful work is expressed thus:

$$\frac{L}{U} = \frac{\mu}{a} \left\{ \frac{1 + a^2}{1 - a\mu} \right\}$$

A diagram is given, Fig. 25, showing the values of the fraction $\frac{L}{U}$, for various values of μ and θ. The values to be ascribed to μ are somewhat difficult to arrive at. In experiments by Bach and Roser on a soft-steel worm meshing with a bronze worm-wheel lubricated copiously with a heavy cylinder oil, μ calculated from the ratio of L to U varied from 0.067 to 0.027, being generally speaking highest at low velocities (50 feet per minute) or at high velocities (over 1000 feet per minute); while at medium velocities (270-550 feet per minute) it was lowest, varying little (0.037 to 0.027) under widely differing loads. In some experiments made by Sellers & Co. on cast-iron surfaces the coefficient was highest at very low velocities (3 feet per minute), and gradually got less as the velocity increased up to 200 feet per minute. The variations of the coefficient are shown in Table 1.

In these experiments the value of μ varied but little for varying values of pressure. Values of μ deduced from Bach and Roser's experiments are given in the accompanying diagram, Fig. 26.

The advantage of employing worms with as large a thread angle as possible, that is to say, with the greatest possible ratio of pitch to diameter, now becomes apparent.

EXPERIMENTS WITH SOFT STEEL WORM AND BRONZE WHEEL.

For a given amount of work to be performed, by doubling the pitch the velocity is halved and the work wasted in heat is materially reduced. The effect is twofold; the temperature of the lubricant being less, its viscosity is sustained; and the velocity being less, the value of the load that may safely be borne is increased. Such experiments as have been made to determine the relationship between the pressure and velocity are not altogether concordant, and it remains to establish firmly the laws which govern this sort of friction. The most careful experiments known to the author were those on a soft-steel worm-gearing, with a bronze worm-wheel, with oil-bath lubrication, made by C. Bach and Roser, alluded to above. The lubricant was a very thick cylinder oil, and the experiments were continued till there was no further rise of temperature, the heat lost through radiation balancing the amount generated in friction. The values of K in Table 2 have been calculated from the experiments. If the values of P are calculated by means of the values of K here given, it must not be assumed that they are the highest values that could be safely adopted, but they represent the pressures which may be adopted for continuous running with limited rise in temperature. It must be pointed out, however, that they are only reliable if the conditions of the original experiments are carried out. These were as follows: The lubricant used was a viscous cylinder oil, and the surfaces soft steel and bronze, the worm dipped into an oil box whose volume was about three times that of the worm, and the worm-wheel was enclosed. It will readily be seen, therefore, that with superior methods of cooling, and by the choice of superior working forces, very much larger working pressures might be realized, especially if the worm be of hardened steel.

The experiments of Messrs. Sellers alluded to above showed that for short periods the value of K for velocities up to 200 feet per minute might be as high as 320 in the case of cast-iron surfaces lubricated with lard oil. For continuous running, however, much lower values should be taken.

Section on Plane Lettered.	Z = Distance of Section from Central Plane.	VALUES OF $\sqrt{\cos. a}$ Pitch = 2 ins. See Fig. 20a. of Text.	Pitch = 6 ins. See Fig. 20 of Text.	Pitch = 12 ins. Not Illustrated.	Pitch = 18 ins. See Fig. 19 of Text.
	Ins.				
DD	1.5	0.440	0.338	No Contact.	No Contact.
CC	1.0	0.454	0.394	0.252	No Contact.
BB	0.5	0.488	0.455	0.399	0.329
AA	0.0	0.508	0.508	0.508	0.508
EE	— 0.5	0.520	0.550	0.587	0.621
FF	— 1.0	0.522	0.573	0.638	0.690
GG	— 1.5	0.523	0.588	0.665	0.725
AVERAGE VALUE.....		0.49	0.48	0.43	0.41

It has been already shown that $b = K\sqrt{R \cos. a}$.

This table shows that the average value for $\sqrt{\cos. a}$ does not greatly alter for very considerable variations of the ratio of worm-thread angle. The pitch radius of the worm is throughout 6 inches.

Refer to Figs. 19, 20, and 20a.

TABLE 3.

At page 80, Volume 29, Part 1, we published an article advocating the aiding of judges in patent cases by unbiased expert advisers employed for the purpose. We note that E. J. Stoddard, referring to 400,000 words of testimony taken out of court, which forms part of the matter that the judge in the Seiden automobile patent case is supposed to mentally digest as a basis for his judgment, has, in the *Horseless Age*, made a proposition similar to the one referred to. If a judge needed help, it surely would seem that this is a case where he would be glad to have it. The fact is, however, probably that, if the mental digestion of this testimony should prove to be a life job for the judge, and if a decision were deferred until automobiles have been superseded by some other means of locomotion and thereby made useless, it would be agreeable to the parties to the suit.

Report of the Apprenticeship Committee of the National Machine Tool Builders' Association

In order to make a thorough analysis of the apprenticeship systems now in use throughout the United States, your committee addressed one hundred representative concerns in this country, inclosing a list of questions bearing on this subject. Fifty-nine of these letters were addressed to machine-tool builders, and forty-one to other manufacturing concerns, such as electrical manufacturers, engine builders, automobile manufacturers, etc., whom, for the sake of brevity, we shall hereafter term "the allied trades."

Replies were received from fifty-one machine-tool builders and twenty-six from concerns engaged in other lines.

For convenience we have divided the country into three geographical divisions, viz., New England, Middle Atlantic States, and Central Western States.

The replies coming from these various sections indicate that 66 per cent. of the concerns located in New England, 55 per cent. in the Middle Atlantic States, and 62 per cent. in the Central Western States employ apprentices, and the majority of them enter into formal agreement to properly instruct the apprentices during a stated period of service.

Eighty-two per cent. of the concerns replying, who had apprentices under the indenture system, were machine-tool builders, and 18 per cent. were from allied trades. Copies of contract were received from a great many, and we find that in certain sections certain forms of contract are uniform, notably in Cincinnati, where the National Metal Trades contract has been adopted.

Regarding the questions which were submitted, we will consider that question No. 1, "Do you indenture apprentices to the machinist trade?" has been answered by the above.

APPRENTICES COMMERCIALLY SATISFACTORY

Question No. 2. "Have such apprentices proven satisfactory from a commercial standpoint?"

Ninety per cent. of replies from concerns employing apprentices indicate that the apprentices have been found satisfactory from a commercial standpoint, whereas 10 per cent. replied in the negative.

At this point it may be of interest to state that the writer investigated this particular phase of the apprenticeship system very thoroughly in the works of The Bullard Machine Tool Company, and finds that apprentices do pay, even when working in opposition to skilled journeymen.

In reaching this conclusion records were taken from the piece-work department covering operations which had been performed by apprentices and by journeymen machinists. Approximately one thousand of these records were taken and the calculations were based on the apprentice labor cost, plus a fixed hourly expense charge, which was the same for both machinist and apprentice. This method of figuring showed conclusively that while the apprentice in certain cases takes longer to do a given operation the lower labor cost at which he is working is sufficient to give him the advantage in the total cost, represented by labor and expense.

Moreover, it is apparent from the records which we secured, that the apprentice does not always take longer to perform a given operation, and frequently, owing to having been thoroughly instructed, he is able to accomplish more in a given time than the journeyman machinist. These cases were all based on piece-work records extending over a period of several years.

They, The Bullard Machine Tool Company, find that the best journeymen they have were trained as apprentices in their own plant. From the replies we should judge that this had been the experience of the majority having had the apprenticeship system in force for any considerable period of time.

NUMBER OF APPRENTICES EMPLOYED

Question No. 3. "What is the approximate ratio between the number of apprentices and machinists employed?"

The replies to this question are more difficult to analyze. The percentages range all the way from 2 per cent. as a minimum to 33 per cent. as a maximum, the average being about 18 per cent. In the allied trades we find that the range runs from 5 per cent. to 20 per cent., and averages about 13 per cent. These figures may be somewhat misleading, as we have assumed that the concerns not replying did not employ apprentices.

Of the twenty-nine manufacturers who employ apprentices under verbal agreement only, 70 per cent. are machine-tool builders, and 30 per cent. engine and machine manufacturers. Of the thirteen concerns who reported employing no apprentices at all, 23 per cent. were machine-tool builders, while 77 per cent. were of the allied trades.

The International Association of Machinists limits the number of apprentices to 12½ per cent. of machinists employed.

It will thus be seen that the machine-tool builders are turning out men for other people to use, as there are many large concerns which employ no apprentices at all, and yet have a large number of machinists. It would be well to note further that the machine-tool builders themselves are not employing as many apprentices as they should, as there is hardly a concern represented at the National Machine Tool Builders' Convention which has not increased its force more within the past few years than the total number of apprentices which have been employed at any one time.

We find that automobile manufacturers as a rule do not employ apprentices, but a number of them have expressed themselves as favorable to such action as the machine-tool builders may take regarding this matter and desirous of being kept informed in relation thereto.

ADVANCEMENT OF APPRENTICES

Question No. 4. "Have graduate apprentices of your works been advanced to position of authority while in your employ?"

Eighty-five per cent. of our replies would indicate that they have, and 15 per cent. are in the negative. No comment would seem necessary, as it is self-evident that if a concern cannot train boys so that they are qualified to take responsible positions in their works, there must be something radically wrong with their system and method of instruction.

DIFFICULTY OF OBTAINING APPRENTICES

Question No. 5. "Is difficulty experienced in securing a sufficient number of intelligent apprentices?"

Seventy per cent. of the replies indicate that there is, while 30 per cent. indicate that there is no particular difficulty. A peculiarity of the replies to this question, taken in conjunction with the wages paid by various concerns, is that the concern paying the minimum wage of 3c. per hour at the beginning of apprenticeship contract, and having a four-year course with a maximum of 10c. per hour, is able to secure a sufficient number of apprentices, and have 20 per cent. of apprentices as compared to journeymen machinists, while several concerns paying higher wages report considerable difficulty in getting enough boys.

We consider this question of the utmost importance as the problem at the present time is apparently to offer sufficient inducement for desirable boys to learn the machinist trade.

It is obvious that the wages paid in one section will vary from those paid in another. It is also apparent that a concern having a reputation for producing good work, and having clean, healthy shops, should be able to secure boys with less difficulty than a concern having the reverse conditions. It is also a question whether wages will attract the right kind of boys. Parents, having the future interest of their sons in mind, should be more solicitous to know that the shop conditions are good and that the boy will have an opportunity to thoroughly learn the trade under competent instructors, than to insist on high remuneration.

We find that the term of apprenticeship varies from three to four years, and that the wages run from 3c. to 12½c. per hour for the first year, from which we conclude that the employer in the former case is either able to get more boys than he needs, or is satisfied with a lower standard than the one who pays something over four times as much.

SCHOOL TRAINING REQUIRED

Question No. 6. "Are applicants re-

quired to have a specific amount of previous school training?"

Eighteen per cent. stated that they insisted upon a certain amount of special training, and one-half of those qualified their reply by stating that they require a common school education only, as it is difficult, if at all possible, to obtain boys who were grammar-school or high-school graduates.

PROVISION OF COURSES OF INSTRUCTION

Question No. 7. "Are courses of instruction provided for apprentices during their term of service?"

To this question 8 per cent. replied in the affirmative. Others reported that they did not provide courses of instruction, but urged the attendance of their boys at night schools, or the taking up of correspondence courses. In one instance the employer pays one-half the tuition, while another, who does not provide the course, offers it as a premium for good service. Four concerns maintain regular schools in connection with their plants, and provide competent instructors free of charge. Two of this number give instruction during the day, and count the time so spent on the apprenticeship contract. The other two require attendance during the evening.

ATTENDANCE ON COURSES OF INSTRUCTION

Question No. 8. "Is attendance on these courses compulsory."

Of the 8 per cent. who provide courses of instruction, 6 per cent. make it compulsory, while the others simply request it.

SPECIAL INSTRUCTORS

Question No. 9. "Are apprentices under the charge of a special instructor while employed in the works?"

Fifteen replies in the affirmative were received to this question, eleven of the concerns having indentured apprentices.

Many replying in the negative stated that the boys are placed in charge of the department foremen, or expert journeymen, who oversee their work, and are supposed to give them proper instruction.

In general the majority of answers are interpreted to mean that the foremen of the departments are the special instructors who have charge of the boys. One concern we understand employs a man to take entire charge of the boys, he having authority over them both in and out of the works.

PREMIUM AND PIECE-WORK SYSTEMS

Question No. 10. "Are apprentices permitted to work on either the premium or piece-work system?"

In answer to this question, fifty-four replies were received, twenty-six in the affirmative, nine stating that they followed this system in part, one allowing the boys to work under this rule after the first year, one after the second year, and one during the fourth year. Of the negative replies four reported that piece-work or premium systems were not in use in their plants.

PROVISION OF SMALL TOOLS

Question No. 11. "Are small tools provided for their use free of charge?"

Eighteen replied in the affirmative, and thirty-eight in the negative. Five reported providing tool-room tools only; one that they provided tools to the value of $25, which was deducted from the bonus of $100 presented at the end of contract; one furnished same at wholesale prices, or on the instalment plan, while another presented the tools at Christmas.

INDUCEMENTS TO TECHNICAL GRADUATES

Question No. 12. "Are inducements of either shorter time or increased pay offered to technical graduates to learn the machinist trade?"

Seventeen replied in the affirmative and thirty-four in the negative. Those replying in the affirmative stated that they increased the wages or cut the time, also offering the opinion that technical schools give false ideas as to salary and position which graduates can command.

We will quote from the negative replies: "Do not believe technical education good for the apprentices or for us;" "Technical graduates do not wish to learn the trade;" "Technical graduates think they know much and demand much."

INDENTURING TO BRANCHES OF THE TRADE

Question No. 13. "Do you indenture apprentices to the various branches of the trade, such as lathe work, planer work, etc.?"

Twelve per cent. replied in the affirmative. One concern which does not indenture apprentices makes specialists almost entirely. They state that these specialists are sometimes changed to other departments, but not often. Another concern make grinding specialists in addition to taking regular apprentices. A prominent lathe maker takes apprentices to the planer and erecting departments in addition to regular apprentices. A planer-manufacturing company takes special apprentices to the planer department. Several others take special apprentices.

CHANGING FROM SPECIAL TO REGULAR APPRENTICESHIP

Question No. 14. "Is any provision made for these special apprentices to become regular apprentices, should they desire, after having completed their special apprenticeship?"

Several concerns make such provision, but it is not universal.

SYNOPSIS OF REPLIES

Having now considered these various questions and replies in detail, we believe it desirable to present the following synopsis, which may serve to place the matter more clearly before you.

1. The majority of machine-tool builders have established apprenticeship systems, which are in more or less satisfactory operation. A smaller percentage of the allied trades have some system, but one large industry, the automobile manufacturers, with one exception, employs no apprentices.

2. Apprentices have proven satisfactory from a commercial standpoint.

3. The approximate ratio between the number of apprentices and journeymen employed by the machine-tool builders is about 18 per cent., whereas the allied trades do not average over 13 per cent.

4. Graduate apprentices have been advanced to positions of authority in many shops. Some concerns state that their foremen come almost entirely from this class.

5. All reports indicate that difficulty is experienced in securing a sufficient number of intelligent apprentices. It seems, however, that the questions of wages and time of service have little effect on this question.

6. But few concerns require a specific amount of previous school training, the majority requiring a common-school education only.

7. As a general rule courses of instruction are not provided for apprentices.

8. Those who do provide such a course make attendance compulsory.

9. Apprentices are usually under the direct charge of the foreman of the department.

10. About 50 per cent. of the concerns employing apprentices permit them to work under either the premium or piece-work systems.

11. Thirty-three per cent. provide small tools free of charge.

12. Thirty-three per cent. offer special inducements to technical graduates, but state that they find it difficult to secure them.

13. Twelve per cent. state that apprentices are taken to the various branches of the machinist trade.

14. But a small percentage of the above make provision for special apprentices to become regular apprentices after having completed their special course.

This problem then resolves itself into the following:

Having an insufficient number of skilled workmen, we can only increase this supply by teaching the machinist trade to an increased number of boys. Finding difficulty in producing a sufficient number of boys for this purpose, we must offer inducements which will attract them to the trade.

RECOMMENDATIONS

We should therefore suggest: First, the drafting of uniform apprenticeship contracts, covering both regular and special apprentices, same to be binding both to the employer and employee, the former to be obliged to properly instruct the latter in the branch or branches of the trade specified in the contract, and we suggest that the articles of indenture provide sufficient guarantee on the part of the apprentice for the satisfactory completion of his time of service, the wages paid to be

optional with the individual employer. We believe this point is essential, as it is apparent from our investigation that apprentice wages vary in different sections of the country. It would seem advisable, however, to have a uniform term of service in all cases to be based on the time found necessary, by previous experience, to properly teach the branch or branches of the trade specified in the contract.

The number of apprentices employed in any shop should be limited only by the ability of the employer to properly instruct them.

Graduate apprentices should be advanced wherever possible, and preference given them in making promotions.

Special apprentices or those indentured to one branch of the trade only should have a common-school education, and regular apprentices, or those indentured to the full trade, to have at least a grammar-school education.

Courses of instruction for apprentices during their term of service should be provided, where practicable, and attendance upon such courses, where provided, be made compulsory. High-school and technical graduates should be exempt from special study during their term of service. A special instructor should be provided where practicable.

Apprentices should be permitted to work on the premium or piece-work systems. All small tools should be provided for their use free of charge, these to be furnished new on completion of their trial period, and presented to them on the satisfactory completion of their term of apprenticeship. These tools should be inspected by an authorized official at stated intervals, and their condition reported. These reports would be valuable in determining the interest and ability of the apprentices.

Technical graduates should be encouraged to indenture themselves to the trade by offering higher wages and shorter period of service. Influence should be brought to bear upon those in authority at the technical schools to impress upon them the demand in the machine-tool business for men having a technical education, and willing to learn the practical side of the business.

Indenture apprentices to the various branches of the machinist trade, making the term of service short and wages relatively high. Offer bonus or reward for the satisfactory completion of apprenticeship.

Offer an opportunity for special apprentices to become regular apprentices, should they so desire on the completion of their special apprenticeship, the time so served applying on the regular apprenticeship course in proportion as may be thought advisable.

Finally, issue a diploma, bearing the seal of the National Machine Tool Builders' Association, to both regular and special apprentices, stating clearly the work accomplished during term of service.

Worm Gear Design

BY ROBERT A. BRUCE

In my criticism at page 144 of W. A. M. Sosa's article on *Worm Gear Design* I endeavored to prove that the limiting end thrust is independent of the tooth pitch, p. Two lines of argument were adopted.

(1) Regarding the state of affairs at any selected moment, I showed that the area of contact depended upon three variables: (a) the number of teeth engaged, which settles the number of surfaces of contact, (b) the width of contact across the face of the teeth, and (c) the relative curvatures of the surfaces which settles the breadth of the contact surface.

(2) Regarding the total surfaces upon which wear is distributed during one revolution, I showed that if the pitch were halved and consequently the wearing surface per tooth likewise halved, this was compensated for by the number of the teeth which share the abrasion during one revolution being doubled.

Mr. Sosa's only reply to this is to bring forward the one-tooth contact theory of gearing. He evidently thinks that this would make all the difference in the world.

ONE-TOOTH CONTACT

Let us see, therefore, what will result if the gearing is so imperfect that the one-tooth contact theory holds good.

Under the assumed conditions there can be only one area of contact at any moment. Upon what does this area depend? It is well here to endeavor to thoroughly grasp what the nature of the contact at any moment between a tooth and a thread is. Mathematically it is a line more or less curved across the face of the teeth. Fig. 1 shows an actual example, the lines $C\,C$ being the projections of the line of contact at certain selected moments. This is not a piece of pure theory. Readers of the AMERICAN MACHINIST will remember O. J. Beale's experimental proof at page 93, Vol. 26 and recognize his positive statement, "the contact between a tooth and a thread is along a line."

From a mathematical point of view, and if we were dealing with ideally rigid materials, no such thing as an area of contact would exist. Owing, however, to the compression of the surfaces and the action of a lubricating film of oil or grease, the ideal contact line becomes a band whose breadth (as opposed to its width or dimension along $C\,C$ across the face of the tooth) is some function of the relative curvature of the surfaces. Its exact

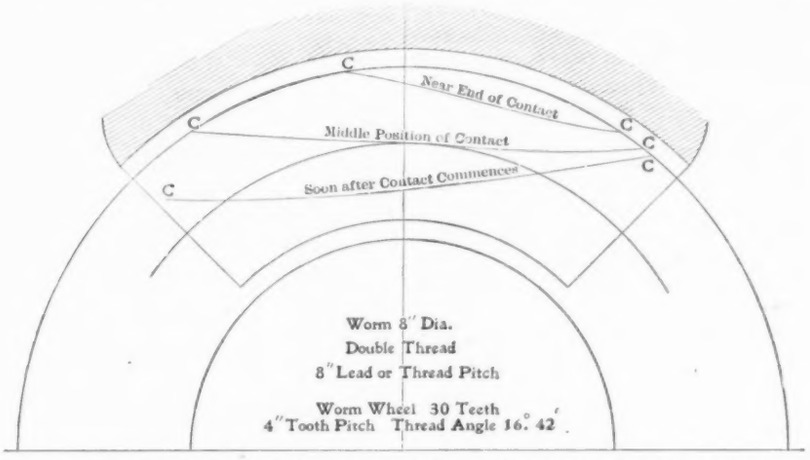


FIG. 1. PROJECTION OF WORM WHEEL TOOTH SHOWING CONTACT LINES C C AT VARIOUS STAGES OF CONTACT

breadth in absolute terms is indeterminable but is certainly very small.

The two elements of the area are, therefore, (a) width and (b) breadth. (a) depends on the diameter of the worm and the angle (which Mr. Sosa fixes at 90 degrees) included between the sides of the worm-wheel teeth. Neither of these is in any way dependent upon the value of p, the tooth pitch. (b) depends upon the relative curvatures of the opposed surfaces. The average relative curvature throughout the range of a tooth's action can be studied without difficulty, as far as the central section is concerned and what is

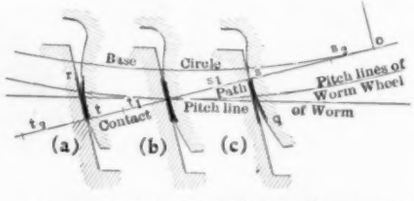


FIG. 2. CENTRAL SECTION THROUGH WORM AND WHEEL

true for the central section is sensibly true for non-central sections.

CONTACT IN THE CENTRAL SECTION

Fig. 2 represents the central section through a worm and wheel, the teeth being shown in three positions, namely, at the beginning, middle and end of contact. The length of the contact path $t\,p\,s$ and that of the acting portions of the profiles (shown thicker as $s\,q$, $r\,t$,) are deter-

mined by the one-tooth contact condition laid down, o being the point of tangency of the path of contact with the base circle. The maximum radius of curvature of the acting face of the worm-wheel tooth profile is $o\,t$, the minimum ditto is $s\,o$ and the mean ditto is $\frac{1}{2}\ (s\,o + o\,t) = p\,o$.

If now the pitch is halved the contact path is also halved and becomes $t_1 s_1$. The greatest, least and mean radii of curvature of the worm-wheel tooth profiles are respectively $t_1\,o$, $s_1\,o$ and $\frac{1}{2}\ (t_1\,o + s_1\,o) = p\,o$ as before. If the pitch is doubled the mean radius is $\frac{1}{2}(t_2 o + s_2 o) = p\,o$, so that as the worm profile is in all three cases straight, the relative curvature is independent of the pitch. When, however, the diameter of the worm wheel is increased, the mean radius $p\,o$ is also increased and hence it is necessary to take the diameter into account.

Purely mathematical reasoning has led me to believe that b (the breadth of the contact streak or band) varies as $\sqrt{D}$.

If the foregoing argument is sound, the area of contact at any moment is independent of the pitch and hence the ability of the worm to resist seizing is also independent of p.

This point of view becomes very plain when it is realized that what Mr. Sosa calls "area of contact" is in the true sense not an area *of contact* but an area *subject to contact*. That is to say, the area is not in contact at any single moment, but the streak or zone of actual contact sweeps over the area as the tooth passes through its phases of action.

Mr. Sosa's "area of contact" represents a "wiped surface" in the sense of the following pertinent sentence taken from Mr. Beale's article already alluded to: "Where any surface has been wiped by moving any piece over the surface, the contact must have been along a line."

It will now, I hope, be clear that Mr. Sosa's theory breaks down even if the one-tooth contact theory be allowed.

My own precept in designing a worm gear is to *increase* my *thread* pitch as much as I dare and to *decrease* my *tooth* pitch as much as I can, making due allowance for the tooth being thinned by wear and time.

PROOF OF THE RELATIONSHIP BETWEEN PRESSURE AND VELOCITY

In expressing preference for his own simple hyperbolic expression for the relationship between pressure and velocity, Mr. Sosa is, I fear, too much influenced by its advantage in use and too little by regard for experimental evidence. It is not necessary to go further than the pages of the AMERICAN MACHINIST to explain this. Experiments by Bach and Roser are given at pages 1018 and 1047, Vol. 26.

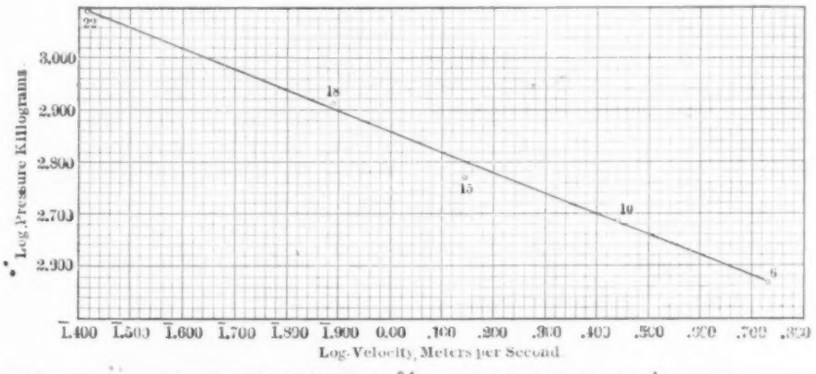


FIG. 3. METHOD OF DEDUCING EQUATION $p\,v^{0.4}$ = CONSTANT FROM BACH'S EXPERIMENTS ON WORMS. FINAL TEMPERATURE 70 DEGREES C. ABOVE ATMOSPHERE

ORIGIN OF THE DISAGREEMENT

It now remains to point out how it is that any disagreement can occur.

Mr. Sosa's method of estimating contact area is to multiply the spiral length by the working depth of the tooth. What does this represent? It represents sufficiently approximately the total surface of one tooth which is, through the tooth's action, subject to wear. If, therefore, this surface be divided by the work done by each tooth it will be representative of its value to stand end thrust.

Suppose the pitch is doubled and consequently (the wheel being constant in diameter) the number of teeth is halved, each tooth has twice as much to do and has to resist twice as much wear. The total wearing area has at the same time been doubled so that no improvement has resulted. Again suppose the pitch, and therefore, the wearing area of the tooth, is halved; no harm results because the work transmitted by each tooth is halved.

Selecting experiments 6, 10, 15, 18, and 22 as representing the relationship between W and V for a nearly constant excess temperature above that of the air of 70 degrees Centigrade, the products of $W \times V$ taken from columns 3 and 7, page 1047, are as follows:

Experiment No.	W (kg)	V (meter per sec.)	$W \times V$
6	369.7	5.37	1984
10	480.7	2.76	1326
15	591.0	1.40	828
18	813.0	0.78	634
22	1257.0	0.26	326

If now we resort to logarithmic plotting, as in Fig. 3, we can deduce the law for this particular series of experiments:

$$W\,v^{0.4} = \text{constant} = 718,$$

as shown by the following figures:

Experiment No.	$W \times v^{.04}$	
6	724	
10	721	mean
15	676	718
18	736	
22	633	

Leeds, England.

An American Corresponding Secretary of the British Weights and Measures Association—His Position with Regard to the Metric System

The British Weights and Measures Association sends us a notice as follows:

"This association, formed for the purpose of opposing the compulsory introduction of the meter or any of its derivatives, and which aims at simplifying British weights and measures and giving them all the properties which the metric system possesses, and other valuable properties which that system lacks, has just appointed Henry Harrison Suplee, a well known engineering expert, of 140 Nassau street, New York, as its corresponding secretary in the United States of America, and Mr. Charles de Grave Sells, M. Inst. C E., M. Inst. N. A., of 1, Piazzi Demarini, Genoa, as its corresponding secretary for Italy. Both these gentlemen are well versed in the metric system, but, like a large number of both English and American engineers and others who have studied the question from its practical side, they are strongly averse to that system becoming the universal system. Apropos of the metric system losing ground as a candidate for the international acceptance, it is interesting to learn that owing to the numerous industries and professions which work in France on other standards than those of the metric system, the French Government are withdrawing some of their vexatious methods of compulsion, as they find such methods of none effect. Article 45 of the Order of April 17th, 1839, which orders that all contraventions relative to illegal standards found in public circulars and announcements shall be reported by the Inspection Department to the Controllers of Registration, is to be no longer enforced, for, says the French Minister of Commerce in a circular which he has sent round to the Chambers of Commerce in France, 'I perceive that if this procedure were followed a considerable number of prosecutions would have to be undertaken, and cause trouble in commercial and industrial operations.'"

As we have understood Mr. Suplee's

position with regard to the metric system, it is not accurately described by the above reference to him, and in response to an inquiry about this we have received from Mr. Suplee a letter in which he says:

"Referring to your letter of 7th about my position in the matter of the metric system, your understanding of it is perfectly correct, and my opposition is simply to any further attempts to introduce it into this country or Great Britain by legislation, as I believe that the present permissive laws are sufficient to enable anyone to use it at will. The statement that I am strongly averse to the metric system becoming the universal system was not authorized by me."

There is at present little essential difference between the two sides to the metric controversy. Very few believe that the metric system should be forced upon any manufacturer, and so far as we know no one at all familiar with manufacturing operations has believed such a thing possible in this country if it is in any. The statement above as to the action of the French Minister of Commerce shows that the French government has at last officially recognized that it is true in France as we have from the first held it to be here, i.e., that government cannot compel manufacturers to use any particular system of measurements. As we have said before, we say again that the metric system can make headway only as the steps toward its adoption are for one reason or another advantageous steps for those who take them.

A Ground Surface Plate

At a recent exhibition in England, some surface plates made by the Crown Works, Chelmsford, were exhibited, which when examined under a strong magnifier seemed to have been finished by some sort of a grinding process, the surface being described as looking as though it had been rubbed with coarse sand. The process of finishing is said to be secret and to be automatic.

So far as the finishing of a surface plate by grinding is concerned, older readers of the AMERICAN MACHINIST may recall that Joshua Rose, many years ago, described in our columns a method he had tried of finishing surface plates by grinding; the work was in that case done by hand, however, the final operation of surfacing being done by fine abrasive materials applied to the high spots of the plate by hand. Very good results were obtained in that way, so far as accuracy was concerned, though we believe at increased cost as compared with ordinary methods and with no appreciable advantages.

Inquiry for Machinery

(185) Wanted, names of manufacturers of special machinery for making taps and dies.

A GERMAN CONTINUOUS STEAM-ENGINE INDICATOR

EDITORIAL CORRESPONDENCE

There has come to be a widespread realization of the advantages and need of a continuous indicator for taking a series of diagrams from engines operating under variable loads, the best demonstration of this realization that I have seen being the extemporized apparatus shown at page 276, Vol. 29, Part 1, and used in the official test of the subway power station of New York.

Such an indicator is especially useful in studying the action of engines acting under a periodically varying load. No matter how industrious and dextrous the operator may be, it is quite impossible in such cases to get individual cards fast enough to give any idea of the periodical action of the engine, whereas a series of continuous cards representing every stroke of the engine throughout the cycle shows the action in a manner which is at once beautiful and to the last degree instructive.

Again, under widely fluctuating loads, whether periodic or not, it is almost impossible to obtain individual cards which shall give the true mean horse-power of the engine. The provision that cards shall be taken at fixed intervals gives no assurance that they shall be representative or that their average shall give the true average of the engine; whereas, except for the labor involved, it is perfectly easy to obtain such a true average from a set of continuous cards.

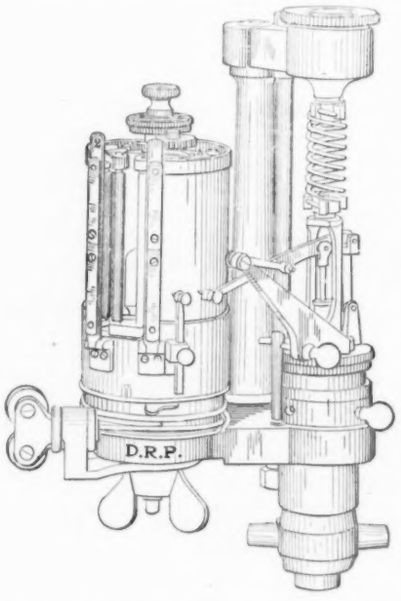


FIG. 1. A GERMAN CONTINUOUS INDICATOR

THE INSTRUMENT DESCRIBED

Illustrated herewith is a continuous indicator made by Dreyer, Rosenkranz & Droop, of Hannover, Germany, of which several have already been imported into this country. Fig. 1 gives a general view of the instrument, which will be seen to be of the external-spring type, although it is also made with an internal spring. Fig. 2 shows a plan of the paper drum, from which it will be seen that a spool of paper is contained within the drum at *a*. From this spool the paper passes without the drum over the guide roll *b*, around the drum, over the second guide roll *c*, to the second spool *d*, on which it is rewound.

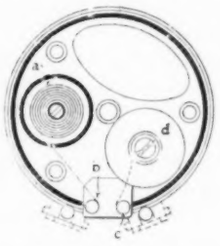


FIG. 2. PAPER DRUM OF CONTINUOUS INDICATOR

In the action of the instrument the paper is drawn out about half an inch and rewound on *d* during each alternate movement of the drum, the result being a series of cards which are offset from one another by the amount which the paper is drawn out.

SAMPLE CARDS

Fig. 3 shows a resulting series of cards from the roughing engine of the No. 1 rail mill of the Lackawanna Steel Company. This engine has obviously throttling regulation, while Fig. 4 shows a corresponding set from an automatic cut-off engine at the Sparrows Point rail mill. The cards tell their own story, which need not be enlarged upon.

TAKING INDIVIDUAL CARDS

By manipulating the thumb nuts at the top of the paper drum the successive drawings-out of the paper may be suspended and the instrument be used for taking individual cards in the usual manner. Again, by suspending the action of the drum, cards may be taken at intervals instead of continuously, if this is desired. The instrument is also furnished with a plain drum, which may be substituted for the continuous drum in a few seconds.

The continuous drum will be seen to be fitted with a pencil for drawing the atmospheric line, a provision that is obviously necessary when taking continuous cards. This pencil is set to agree with the position of the main pencil when the piston is free from pressure, and thereafter draws a continuous line as the paper passes out and around the cylinder.

F. A. H.

MANUFACTURING INDUSTRIES FOR THE PERIOD 1900–1905

Some Particulars From the Last Census Relating to the Capital Invested in Manufactures, the Number of People Employed and the Value of the Products

The results of the last census of manufactures for the entire United States shows that there has been an increase from 207,562 in 1900 to 216,262 establishments in 1905, in each of which the value of the production was in excess of $500. The total invested capital has increased from $8,878,825,200 to $12,686,265,673. The number of salaried employees has increased from 364,202 receiving $380,889,091 in 1900, to 519,751 receiving $574,761,231 in 1905. The total average number of wage-earners reported in the census of 1900 was 4,715,023, and in that of 1905, 5,470,321, while their wages increased from $2,002,735,799 to $2,611,540,532, an increase of 16 and 29.9 per cent. respectively. The cost of materials showed an increase from $6,577,614,074 to $8,503,949,476, or 29.3 per cent. The total value of the products reported in 1900 was $11,411,121,122; in 1905 it was $14,802,147,087, an increase of 29.7 per cent. Of all these establishments there are 24,180 for which the value of products is $100,000 or over, only 11.2 per cent. of the total; yet they control 81.5 per cent. of the total number of wage-earners, and manufacture 79.3 per cent. of the total value of the products.

THE LEADING MANUFACTURING SECTIONS

New York, Pennsylvania, Illinois, and Massachusetts are, in the order named, the four leading manufacturing States. They contain 86,333, or 39.9 per cent., of the establishments of the entire country, give employment to 2,488,064, or 45.5 per cent., of the average number of wage-earners, and reported $6,978,331,091, or 47.1 per cent., of the value of the products.

The States east of the Mississippi river and north of the Mason and Dixon line and the Ohio river contain 65.5 per cent. of the establishments in the United States, give employment to 71.1 per cent. of the wage-earners, and reported 73 per cent. of the total value of the products.

IRON- AND STEEL-WORKING ESTABLISHMENTS

As between 1900 and 1905 there has been an increase in the number of iron- and steel-working plants from 13,874 to 14,239, in capital invested therein from $1,538,459,831 to $2,331,498,157, in salaried officers and clerks from 50,098 earning $58,431,506 to 82,112 earning $100,444,686. The average number of wage-earners has increased from 737,986 receiving $384,233,365 to 857,298 earning $482,357,503.

THE OUTPUT OF FORGING MACHINERY, PRESSES, SHEARS, ETC.

In 1900, the number of hammers, steam, power and, drop made was 857, valued at $671,287; the number manufactured in 1905 was 1934, worth $832,698. Of forging machines, bolt headers, etc., there were made 821 in 1900 at $424,774, and in 1905, 390 at $437,097; of stamping, flanging and forming machines there was an increase from 7895 at $1,180,960 to 8235 at $2,003,861; punching and shearing machines decreased in number from 5269 to 4382, with an increase in value from $1,219,605 to $1,425,510; in 1900, 914 bending and straightening rolls were turned out at $202,230; in 1905 only 174 were made at $190,578. Riveting machines increased from 202 at $139,295 to 645 at $238,829.

MACHINE TOOLS

The number of hand lathes decreased from 3945 at $306,081 to 3912 at $190,576, and of engine lathes from 12,089 at $4,451,867 to 7676 at $3,523,470. Also the number of turret lathes dropped from 3687 at $2,449,121 to 2898 at $2,210,814.

The number of boring and drilling machines, of all classes, manufactured in 1900 was 22,890, valued at $2,779,983; in 1905 the number had increased to 23,579, while the value decreased to $2,369,712. The number of planers, including plate-edge planers manufactured in 1900 was 1543 at $1,808,955, and in 1905, 1100 at $1,551,616. The number of slotters and shapers was reduced from 3076 at $1,136,350 to 2012 at $845,860; also the number of milling machines, including all machines using a milling cutter, fell from 4119 at $2,171,966, to 4032 at $2,476,626, an increase in value.

SAWS, POLISHING APPARATUS, BOLT CUTTERS, ETC.

Sawing machines fell from 2846 at $222,563 to 2806 at $165,428. The number of brazing and polishing machines, including all machines using abrasive material, increased from 10,014 at $880,965 to 19,193 at $1,310,903. The number of bolt, nut, and pipe-threading and tapping machines turned out in 1900 was 2088 at $698,362; by 1905 the number had increased to 2687 at $899,197. The number of pneumatic hand tools increased from 6751 at $143,325 to 19,297 at $1,732,107; and in addition to these, other machinery increased from $2,726,901 to $9,090,189. The total value of metal-working machinery manufactured in 1900 was $24,737,904 and in 1905, $32,408,766.

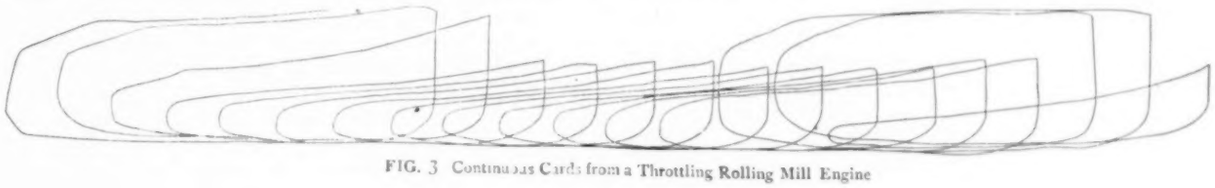


FIG. 3 Continuous Cards from a Throttling Rolling Mill Engine

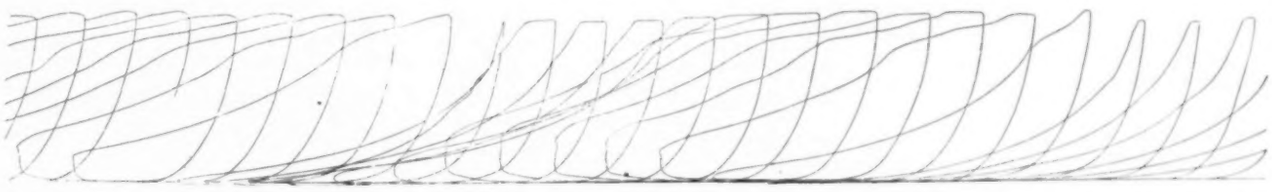


FIG. 4. CONTINUOUS CARDS FROM AUTOMATIC CUT-OFF ROLLING MILL ENGINE

Opening of a Portion of an Up-to-Date Interurban Electric Railway

What will be, when completed, one of the largest interurban electric railways in this country, The Rochester, Syracuse & Eastern Railway, connecting the cities of Rochester and Syracuse, N. Y., has now opened up 37 miles of the entire length of 83 miles from Rochester to Lyons. It is expected that it will cost $6,000,000 to complete the road. The road bed, which in many instances traverses private right of way, is of the most substantial construction.

The power-house equipment includes Westinghouse-Parsons steam turbines with Westinghouse generators, as well

as switchboard and auxiliary machinery. The cars are solidly built, weighing approximately 50 tons and measuring 54 feet in length by 8½ feet in width. Each car is equipped with four 125-h.p. Westinghouse motors, Westinghouse multiple-unit control and air-brakes. The company will operate express trains and accommodation trains, the former running at a regular schedule speed of from 50 to 60 miles an hour. On a recent trial trip a few days ago, one of the cars attained a speed of 70 miles an hour. It is expected that the entire road from Rochester to Syracuse will be completed and in full operation by January 1, 1908.

Legal Notes—What is Machinery?—Satisfaction

BY E. P. BUFFET

An insurance case passed on by the Supreme Court of Iowa brings up a question: What is covered by the word "machinery"? The machinery forming the subject matter of this action was that "of all kinds and descriptions while contained" in a certain laundry. The trial court had charged as follows: "The boiler, all pipes connecting it with the other apparatus used in the business, the pipes and apparatus, if any, of the drying room, the steel tanks, all shafting, belting and hangers for shafting, contained in the building are machinery within the meaning of the term as used in the policy, as well as such apparatus as would ordinarily be spoken of as machines." It was objected that the boiler, pipes and fittings had no proper place in that category because, it was said, "they did not convey or regulate force. They did not contribute in the remotest degree to keep any kind of machine or appliances in action or motion." Machinery is somewhat narrowly and technically defined as "the working parts of a machine, engine or instrument arranged and constructed so as to apply and regulate force." But the appeal court, in sustaining the decision of the trial court, prefers to follow here the broader definitions: "Machine—any mechanical contrivance;" "Machinery—the means and appliances by which anything is kept in action or a desired result is obtained; a complete [or complex] system of parts adapted to a purpose." The court says that the term is usually employed in the broad sense, and that it is a well established rule of insurance law that a policy is to be construed most liberally in the interest of the insured. The steam here was used not only for motive power, but for drying, etc. Boiler, pipes, washers, irons, mangles, etc., make up a complete system of parts adapted to the purpose of operating the laundry. "Disconnected from the boiler, some of the parts might be machines in the technical sense, and others might not be machines in any sense, but when combined and suitably connected ready for operation for laundry purposes, the entire outfit is machinery in the proper and commonly accepted use of the term. If an implement dealer procures insurance on his 'machinery' in store, no one would seriously contend that, for the loss of a traction engine under such policy, the company would not be liable for the value of the boiler as well as for the combination of wheels and movable parts making up the engine proper. In the laundry we have the same combination of boiler and engine or other mechanism by which a desired result is obtained, and the fact that the boiler is not mounted on wheels or that the union between boiler and other mechanism is effected through a greater length of pipe makes the entire apparatus none the less a single system of machinery."

It is well to bear in mind that, as the court remarks, insurance policies are construed most liberally for the insured, so that it does not follow that in the construction of some other form of contract so generous a classification of machinery would necessarily be made.

WHAT CONSTITUTES SATISFACTION

When the sale of an article or performance of work is contracted for on condition that it gives "satisfaction," a distinction is made between different classes of cases in determining what "satisfaction" means. Where the subject matter of the contract is one the judgment of which naturally depends on his personal taste, preference or convenience, such as a portrait, the party exercising the decision has a right to plead dissatisfaction, even though it may be unreasonable in him to do so. But in a class of cases where individual taste is not properly an element, e. g., the repair of a boiler, it has been held in New York that he is bound to be satisfied if a reasonable man would be satisfied under the circumstances. The Supreme Court of North Dakota has lately made a ruling on this point in a manner which, as in Massachusetts, is contrary to the New York rule. It has decided in a case of a harvesting machine that if a party took it on trial with a privilege of return provided he were not satisfied, he was not bound to be satisfied, even if an ordinary man would have been. A qualifying clause, however, is added to this opinion. The purchaser must actually and in good faith be dissatisfied and not, from selfish or other unworthy motives, pretend to be so.

RELIEF FROM INSPECTING SIMPLE TOOLS

Whether an employer's duty to provide safe appliances for work requires him to inspect simple tools, was considered in a quite recent Minnesota case. A blacksmith sought to recover damages for injury to his eye by a piece of metal flying from an ordinary sledgehammer, which, he alleged, had been in obviously bad condition for some time previous to the accident, although when it was new and furnished to him it proves to have been of such a grade that no negligence was involved therein. The Supreme Court lays down that "when the appliances or machinery furnished employees are at all complicated in character or construction, the employer is charged with the duty of making such reasonable inspection as is necessary to detect defects. But the master is under no duty to inspect simple or common tools, or to discover or remedy defects arising necessarily from the ordinary use of such instruments." Among the precedents cited is an exception to this rule in case of a monkey wrench, but based upon unusual circumstances. Another exception was in case of a "flogging hammer" made by the employer and kept in a toolroom under an inspector; such hammers being of special character in respect to tempering and condition for use. But the court considers the hammer in the case at bar to have been "about as simple in construction and as easy to understand as a club."

Another Minnesota case, shortly following that of the sledgehammer, applies this same doctrine of non-obligation to inspect. A machinery oiler there sought to recover for injury by fall of a ladder, which he claimed had lost one of the brads at the bottom which kept it from slipping.

Regulations as to Denatured Alcohol

The committee of manufacturers formed to assist in securing cheaper alcohol for industrial purposes, whose address is at 21 William street, New York City, send us a copy of the Regulations and Instructions concerning Denatured Alcohol, issued by the Government Printing Office at Washington, and known as "Regulations No. 30, United States Internal Revenue." We understand that this can be obtained by any interested person from the department. Concerning it the committee referred to say: "These regulations are intended to permit the freest possible use of industrial alcohol, and will, we believe, be found generally satisfactory to the interests on whose behalf Congress removed the tax from alcohol made unfit for beverage purposes.

"The requirements of the regulations in regard to the production, sale and use of denatured alcohol can easily be complied with, and will make it possible for consumers of this material to secure it at a very moderate price.

The present address of Frank B. Kleinhans, formerly of Philadelphia, and later of Pittsburg, is desired. Will anyone knowing the address kindly send it to the editor?

CORRESPONDENCE

Discussing Phases of Machine Design and Construction

Boring Bars and Cutters—The Use of Wedges in Boring Bars

Persons sometimes become very set in their ideas mechanically as well as otherwise. Perhaps I have become somewhat fossilized; if so, the reasons are these:

When serving my apprenticeship I received many admonitions against the use of poor tools, and to cultivate an ability to be a judge of what is prudent. The foreman of the shop was opposed to the use of wedges for holding cutters in boring bars whenever it was possible to use anything else. These impressions I have for years applied with such satisfactory results, that I continue to condemn the *Time Honored Wedge.*

So many methods of holding inserted cutters have been recently shown, that the subject is clear in mind.

Fig. 1 shows a well known form of cutter held by a set screw and adjusted by another set screw. A bar with a cutter of this kind is applicable to almost any work where a fly cutter can be used for boring or chasing; the ease and certainty with which the cutter can be adjusted makes it especially useful for the latter.

Fig. 2 is also a well known form; the wedge is intended to locate the cutter; by fitting in the center and by affording a three-point bearing it avoids springing the bar when driven in.

Fig. 3. This form is intended, in addition to its uses shown at page 677, Vol. 29, Part 1, to hold any form of a flat, square, or round cutter for boring, chasing and facing. The ease with which different forms of cutters are held or removed gives it many advantages over the wedge. A bar of this kind is equally adapted to lathe, drill press, vertical and horizontal boring machines.

The cutters, *B, C, D, E* and *F* give an idea of a few of the different kinds that may be held by the block *X-1*. *G* and *H* show a form to be held by the block *X-2*. Almost every form of ordinary, and many forms of special cutters can be conveniently used in this bar by having a few blocks as shown, and an unlimited supply of wedges and liners is not necessary.

U. B. S.

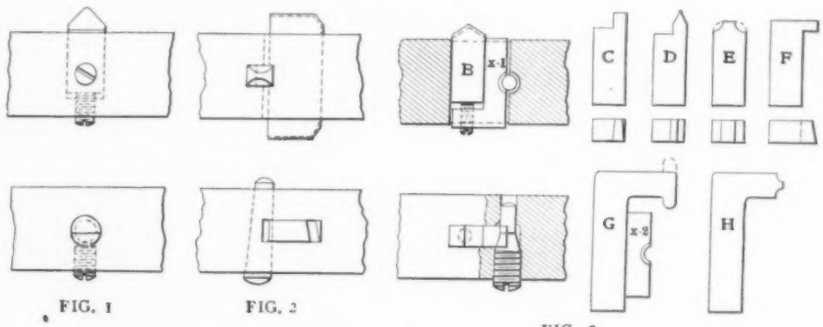


FIG. 1 FIG. 2 FIG. 3

BORING-BAR CUTTERS

Clamping the Tail Spindle—Journal Bearings

The method of clamping the tail spindle which W. S. Leonard shows at page 513 is certainly good. It is good if he can give us some assurance that it will be used as he says. What experience I have had with lathes makes me feel as if this extra binder nut would be set to the mark which he is going to put on it only about twice in an ordinary working year of 300 days. The rest of the time it will be set any old way, usually either too tight or else to some one of the half dozen other marks that various men think better than the original one. This is such an old trick on the set-over slide of a tailstock that no lathe hand could resist the temptation to put on his own private mark. If, as I should judge would most often happen, this extra binder is set too tight, then undue wear may be expected because the film of oil which we usually expect to maintain between two surfaces is squeezed out. If, on the other hand, the old-style tail spindle is used for chucking work it will play up and down or around and wear out. If on the other hand, the old-style lathe tailstock with a single binder screw is fitted right to begin with it will stay right for an indefinite length of time. With the old-style single binder, if the spindle is made a good fit but fairly free so that there is room enough for a film of oil, then the thing will wear a long time, probably longer than the lathe ought to be kept in commission anyway. And if the tail spindle is well fitted it will take only a very little to bind it against endwise motion with the single clamp. If it is well fitted, and only so well fitted as is the custom in most high-grade lathes, then there will be no appreciable give of the spindle at the back end where it is not clamped. This matter of wear in an adjustable bearing is something that Professor Sweet illustrated years ago by his reference to the cone pulley of a lathe. He made the general statement that such pulleys seldom wear out. Since he wrote that I have seen a great many second-hand lathes taken apart and I never have seen a cone-pulley bearing roughed up or worn loose. The secret, if it is any secret, appears to be this: The bearing is not adjustable in any way. The stresses brought on the bearing are not such as to be apt to disturb the fit, and it is something that is easily fitted and yet something that is apt to be put in the hands of an extra good workman to make.

SHOWING LOOSE FIT BETWEEN BOX AND SHAFT

In this connection a suggestion to Mr. Plaisted, who (at page 485) is seeking for light on bearings, may be pertinent. May it not be possible that the design of a bearing (journal) ought to be influenced by the workmanship which can be relied on to be used? It often happens that a bearing may have contact with its journal over but a small fraction of its area, in which case a comparatively small load may cause it to heat, due to the fact that there

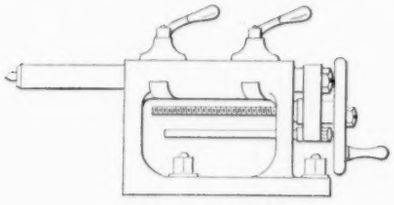
is actual contact of metal on metal—instead of a film of oil supporting the load. This may come about through a poorly scraped box, a bent shaft (and it may be bent when running and yet straight when tested), or to too loose a fit between box and shaft. The sketch shows on an exaggerated scale the possibilities in the latter case. Oil tends to settle to the bottom of the box, but the weight of the shaft and load tends to squeeze it out. Only where this film of oil is thin, but not quite squeezed out, does it carry the load. So in such a case the load is concentrated on a much less area than that at which the bearing would be computed. In case of the cone pulley, or any well fitted non-adjustable bearing, probably there is seldom actual contact between shaft and pulley when running. The friction of the two surfaces is replaced by the friction of the globules of oil, one on another, and not even the oil itself wears out, as witness the fact that these bearings are not oiled with anything like regularity.

E. H. FISH.

Worcester Polytechnic Institute.

Clamping the Tail-spindle

I was much interested in what W. S. Leonard had to say about clamping the tail-spindle, at page 513. Many a time have I wished for some such clamping device as he describes while trying to take a heavy cut off some irregular surface with the tail-spindle out about a foot. The accompanying sketch will give an idea of an old lathe tailstock which I ran



AN OLD TAILSTOCK

across on the edge of civilization some years ago. Although it is rather cumbersome the spindle can be clamped as tight as the arm of a milling machine if desired. The lathe was made somewhere in Scotland, whether A. D. or B. C. it would be hard to tell from its general appearance.

W. L. Mc L.

Canada.

Cast-iron Beams

Although in common with Peter Palmer I had considered the original discussion on cast-iron beams closed, the appearance of his article at page 385, together with that of F. M. B., at page 384, prompts me to put in a word for the method of the English text-books without recourse to those of Continental origin. The formulas and rules attributable to Professor Bach at page 385 may be good, but the method given below, which is quite common, considers every point in the problem and arrives at a proportion quite in keeping with the results given in the original article.

First to find the center of gravity of the beam.

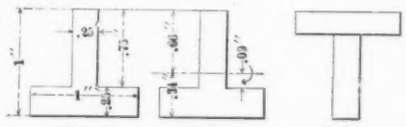


FIG. 1 FIG. 2 FIG. 3

CAST-IRON BEAMS

Take moments at the top edge (as in Figs. 1 and 2) thus:

Areas		Arm		Moment
$0.25 \times 0.75 = 0.1875$	$\times$	0.375	$=$	0.7
$1.0 \times 0.25 = 0.25$	$\times$	0.875	$=$	0.218
0.4375	$\times$			0.29 approx.

But center of gravity arm $\times$ by whole area = sum of moments.

$\therefore$ center of gravity arm

$$= \frac{0.29}{0.4375} = 0.66 \text{ inch.}$$

or the center of gravity lies at a point = .66 inch from top edge.

Next to find the moments of inertia:

Part above neutral axis

$$I_1 = \tfrac{1}{3} BH^3 = \tfrac{1}{3} (0.25 \times 0.66^3) = 0.285.$$

Part below neutral axis

$$I_2 = \tfrac{1}{3}(BH^3 - bh^3) = \tfrac{1}{3}(1 \times 0.34^3 - 0.75 \times 0.09^3) = 0.0129$$

Total moment of inertia

$$I_1 + I_2 = 0.0285 + 0.0129 = 0.0414.$$

Modulus of compression

$$= \frac{0.0414}{0.66} = 0.063.$$

Modulus of tension

$$= \frac{0.0414}{0.34} = 0.122.$$

These figures are reversed by the alteration of the beam thus:

Figures.	Modulus of Compression.	Modulus of Tension.
1 and 2	0.063	0.122
3	0.122	0.063

The ultimate strength by compression is taken at 5 times that of tension, for cast iron.

Relative Strengths.	Compression.	Tension.
Figs. 1 and 2	0.315	0.122
Fig. 3	0.610	0.063

Which proves the position of Figs. 1 and 2 to be roughly twice as strong as that of Fig. 3.

Taking the tension strength of cast iron at the average of, say, 8 tons, the breaking strain of the beam when bending movement $= \frac{W.L.}{4}$ is, for Figs. 1 and 2,

$$W = \frac{8 \times 0.122 \times 4}{12} = 0.325 \text{ tons.}$$

and for Fig. 3,

$$W = \frac{8 \times 0.063 \times 4}{12} = 0.168 \text{ tons.}$$

This shows, assuming the bars tested as described, that the metal must have had an ultimate strength (tension) in Figs. 1 and 2 of

$$\frac{0.88 \times 8}{0.325} = 21.13 \text{ tons.}$$

which is, of course, abnormal.

However, the proportions are correct and I think it can fairly be claimed that when the explanation is eliminated the working is extremely simple.

As to F. M. B.'s method, which is also, I believe, in common use, I myself am not in favor of it, the balancing of the paper templets and finally the shaded areas not being conducive to accuracy, besides the undoubted fact that in the majority of instances it would involve loss of time.

SIRRAH.

England.

Reboring a Large Sheave

Our ingenious and resourceful friend referred to in the article, "Another Odd Material," at page 514, had another job which illustrates how results may be accomplished with limited facilities.

The shaft, carrying a 12-foot cast-iron sheave which transmitted the power necessary to drive a planing mill, broke close to the hub. This had occurred before so our friend was called in consultation. It was decided to rebore the sheave and replace the broken shaft with a larger one.

The sheave was located in a tower on top of the mill about 50 feet from the ground. As it was necessary to take it to the machine shop which was not far, our friend after having made the necessary measurements, left that part of the work to the mill foreman and his men while he went to the shop to prepare the boring bar and get a new shaft started. The lowering of the sheave from the tower to the ground was accomplished safely and in good time. As a suitable conveyance was not at hand, the sheave was rolled on its rim to the machine shop, this being accomplished without great effort. As the sheave was too large to pass through the door of the shop it was laid outside upon suitable blocking arranged to afford a three-point bearing when the sheave was laid horizontally upon it. In this position it was leveled. In the meanwhile a boring bar had been made out of a piece of old shafting. One end was reduced to the size of the bore of the sheave, for a distance equal to the length of the hub, then for an equal distance to the size it had been decided to enlarge the bore. At the shoulder between the two different diameters a suitable cutter was inserted of a length equal to the required bore. A groove was planed in the bar from the cutter to the end. This was to allow the chips to escape. The bar was inserted in the bore after driving a hard maple strip tightly into the old keyseat. A pulley was secured to the upper end of the bar for a driver. The power to drive the bar was taken from the line shaft of the shop by means of a belt. As the shaft was at right angles and above the scene of operations, a mule stand was arranged, consisting of a piece of steam pipe, in lieu of a shaft, set up at the required angle and secured by stays. This carried two pulleys which had been hurriedly made of wood.

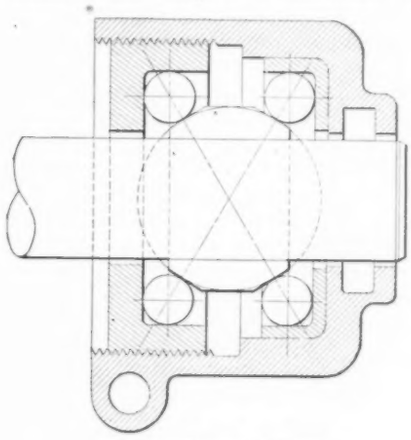
The belt consisted of various widths and lengths taken from the machine tools in the shop. The location and adjustment of the mule was made with satisfactory results, after the belt was put on and the power slowly started.

To provide the necessary feed to the cutter, an empty nail keg was set upon the driven pulley on the upper end of the bar, this was filled with scrap iron of sufficient weight. The boring proceeded at good speed without further trouble and the result was all that could be desired. After chipping and filing the new keyseat the sheave was returned to its original position in the same way it was taken down and is still running to everyone's satisfaction. This occurred some years ago.

H. D. POMEROY.

A Defective Ball-bearing Design

At page 515 appears an illustration of defective ball-bearing design, but it is defective only so far as the purpose for which it was designed is concerned. I



A BALL-BEARING DESIGN

inclose a sketch of a ball bearing used on the shaft of an electric vehicle motor in which the very principle that made the other bearing defective is made use of to make this bearing self alining.

The balls are so located that the beveled edges of the cones are tangent to a circle struck from the center of the axle, thus allowing the bearing to oscillate slightly in a direction parallel to the shaft.

S. BLISS.

Knowing What To Do

Some time ago, while visiting a large malleable-iron plant in an Eastern city, I witnessed a peculiar accident which impressed me with the importance of having men in charge of departments who know what to do in an emergency.

The accident occurred soon after the heat had been started. The stack was fire-brick lined and in some way one section of the lining had been loosened and fell out, leaving a hole where the intense heat came in direct contact with the outside shell of the stack and either threatened the destruction of the stack or necessitated the pulling off of the heat, either of which would cause great financial loss.

A hurried consultation of superintendent and foremen was called. The foreman of the annealing room, at once grasping the situation, called for a ladder to be placed against the stack and taking a sharp punch and a hammer and climbing to the heated portion, there made several small holes in the shell, thus allowing the cold air to draw the heat away from the place where the bricks were gone in the stack.

Denver, Colo. E. W. BOWEN.

Osborne's Experiences with Cast-iron Beams — Fools Who Know They are Fools and Fools Who Do Not

"Yes, I'm a fool; but I'm not so big a fool as you are, for I know I'm a fool and you don't know you are a fool." Out of the mouth of fools cometh wisdom, and the wisdom of the above foolishness would have done credit to Solomon.

Knowledge of any sort, no matter how accurate, is pretty poor property unless you can put your finger on it when you need it, and unless you can apply it with precision to the case in hand. Osborne's experiences with the formulas for cast-iron beams, and the comment his entertaining article has called out in subsequent numbers, goes to show the woeful lack of some of our standard sources of information in both these respects.

To the man whose knowledge of the differential calculus—and other things that sound more like a druggist's prescriptions than "figgering"—is limited to hearsay, there is more meat in such an article as that by F. M. B., at page 384, than in whole chapters transcribed from the "major master minds" by the "minor master minds." Osborne isn't often sarcastic, but that bit is certainly one of his jewels. How I wish F. M. B. had written that little thing 20 years ago; it would have saved me so many long and often fruitless searches in the pages of knowledge bound in limp leather, and which don't seem to fit many cases outside their covers.

Only a few weeks ago I could have made good use of it. I was asked for the safe load that a certain section of steel rail would support when laid across the side walls of a culvert under a highway, in order that these rails might be properly spaced lengthwise of the culvert. All the dimensions were given, apparently, and it seemed a simple case of working the formula for transverse strength; but when I went hunting for the value of R, or moment of resistance, I was soon up a stump. Not in the catalog showing full-sized outlines of the rails rolled by the maker of those in question, nor in any other similar book, were any of the moments of those sections given, and not even the area was to be had, except by actual measurement. Of course nothing in the Pocket Books applied to such a case with accuracy, and for a few moments I was ready to agree with a certain Mrs. Malaprop, who opined that it took "a corresponsible man to build culprits on a railroad." Then I happened on the general formula for deck beams, which gives R approximately when the area and hight are known. With the aid of this I worked out a solution that may have been nearer right than I could have guessed at; but that was about all the confidence I had in my figures after I got them so laboriously.

Another case I recall which happened in my early days. Though I was then a cub in the shop, I was also the draftsman and sole assistant to my old boss as designer. Not so very far back of that time the "drawings" were made on the smooth side of a pine plank with a two-foot rule and a carpenter's compass.

The boss, like myself, had to depend on horse sense instead of mathematics when they soared upward into the blue ethereal hights, and all the "pure science" we could both shell out wouldn't have filled a thimble. Still we contrived to get out some machines that subsequent years have not improved greatly, and we usually put enough iron into them to assure a liberal "factor of safety."

STARTING TO DESIGN A MACHINE WITH A WRONG PREMISE

This machine I am now thinking of was a planer for surfacing piano sounding boards. It was to take in stock 5 feet wide, and the table was to tilt so that the thickness could be varied as much as $\frac{5}{8}$ inch between the extreme edges. There were other unusual features and it became a very interesting problem to both of us. Owing to the extreme width, the trussing of the bed, or table, must be ample; and as we then had no better light on the subject, we compared it to a bridge, considering the sides, or legs, of the machine as its abutments. Bridges generally are deep in section at the abutments, arching upward to a rather shallow central member, and on those lines, with a beautifully curved arch, we constructed that planer bed. It certainly looked good to us, in cast iron; but on paper, and after being worked through a formula for transverse strength, it wouldn't have held its own with a counterfeit 30-cent piece. It speaks volumes for the strength and general abundance of our metal when I say that, aside from ourselves, no one found out that the bed was not as it should be, and we came to that conclusion only by reason of accumulated experience and observation. It gave satisfaction to its purchasers and our blunder harmed no one; but when a fire gave us a chance to replace this machine the new one had a bed

with trusses deepest at the center, even if bridges are not usually built that way.

A PLEA FOR COMPREHENSIVE INDEXING

I wish F. M. B. had gone a little further and told us just where to look for that method for reducing any section to an I for purposes of calculation, for I haven't been able to locate it, though it may be in each and every one of my Pocket Books, and I lacking understanding to look in the right place and for the right thing. Making an index fool proof is not an easy matter, and perhaps the Pocket Book men have done the best they could at it, but I hunted a long time in Kent to find the tensile strength of hard pine (the index giving the leading Properties of Timber) and if that thick little volume has the tensile strength of brass anywhere between its covers, I haven't been cute enough to smell it out.

Hard pine is another material which might have caused the "authority" Osborne wrote to to slip up and bump his intellect on the neutral axis if he forgot the location of his own center of gravity. Its tensile strength is generally given as 16,000 pounds per inch, and crushing strength at only a trifle over one-half this figure.

A SIMPLE POCKET BOOK WANTED

With such a howling demand for what F. M. B. calls a simple A B C Pocket Book of boiled-down formulas in plain English and arithmetic, it is strange no one makes a move to supply the want. Is it because of the "holier than thou" attitude the "minor master minds" might assume toward it, or because we common fellows have been giving Pocket Books in general so many knocks of late? Perhaps we have overdone the matter, though we have most of us been there, and can appreciate the atmosphere which Osborne said was fit only for a college man to breathe; and so when one of us puts up a groan, the rest growl in unison of sympathy. When the air gets surcharged with molecules of that kind, a little wholesome azure-tinted profanity has been known to restore it to equilibrium, same as it used to keep the blood from settling under the nail when we jammed our fingers in shop days. The loftiest flights finally come back to earth, and sometimes with what seems to us common chaps a very ordinary sort of a thud.

WHO SHOULD CHECK THE DRAWINGS?

I quite agree with Entropy in the matter of letting the first users of a drawing do the checking when it is a machine that is to become a standard product, built in quantities. I won't say it is impossible to make a design so perfected and well thought out that no chance for betterment will appear when it is made up in metal, but admit that I never yet succeeded in doing it, nor ever expect to. If we have anything that could be called a system in this matter, it is encouraging of everyone who comes in contact with that machine, from the patternmaker's apprentice to the painter, to find as many faults as he can suggest the betterment for. This may result in drawings, patterns, or even finished castings being rendered useless, and these might seem to the layman, like Pessimist's piles of worthless jigs, as so much good money wasted; but that is a very superficial view of the case, as all practical men know. In the majority of cases these apparently expensive mistakes have each served a useful purpose, and been very well worth while as a means to an end.

SUCCESSFUL DEVICES ALWAYS THE RESULT OF EVOLUTION. FAKES ARE PERFECT FROM THEIR INCEPTION

Of course, as Pessimist says, if Fulton could have invented the modern ocean liner instead of the "Clermont" it would be quite another matter; but as far back as we can trace the records left by man or by nature, evolution has been the principle underlying all things that have endured. Inventors of the Poleforcia type, the Sleepy Eye breed, bring forth the children of their imagination fully grown at birth, perfected down to the last little screw before a plank is cut for the first pattern; but the things that have changed the face of the globe and the destinies of nations have had to be evolved by slow degrees, and usually by the combined thought and labor of a great many separate workers.

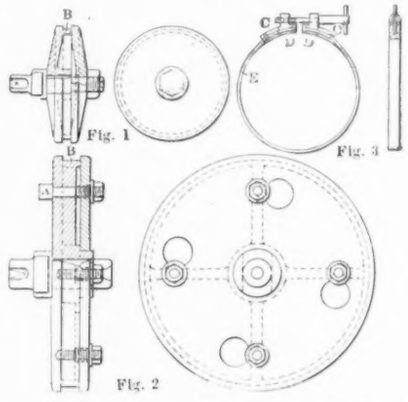
It may make a draftsman tired to have to re-draw a whole sheet of intricate detail, just because some smart aleck has found a way to improve one small part shown thereon, and it may make the stockholders tired to see their "good money" going into jigs and patterns that are soon to become worthless; but men who get tired that way are, like Bill Nye's chambermaid, out of their proper sphere. She told Bill that she had spent two years at Heidelberg training her voice for chamberwork; had learned to fold the sheets with accordion pleating across the top, and was past mistress of the art of giving a bed an air of downy fluffiness, even when it was actually in a state of collapse. But she had grown tired of spending these accomplishments on ordinary people in whom she took no interest.

If Mr. Porter could overlook the effect of reversing the motion of 29 pounds of surplus metal 460 times per minute when he was hunting for the trouble in his governor, is it any wonder other designers fail to foresee what may result from this and from that when the thing is actually built and put in operation? He tells us he was thoroughly ashamed of himself for the oversight; but how many inventors of his rank and achievements do you suppose have had less cause, on the whole, to kick themselves? According to his narrative, it is now over 30 years since it was shown that "Old Whitworth lied," and we are still using his lying formula. How mighty a thing is the force of habit and precedent.

We should be grateful to the man who had the courage to say "much uncertainty exists in the whole matter." We can place all the more confidence in those things he does claim to be reasonably certain about. Those who pose as leaders should not only be familiar with the language of the guideboards, but have a general idea of the lay of the land as well; for sometimes we have to leave the beaten track and cut across lots. The leader should at least know whether it is the devil or the deep sea that lies in wait for us on the other side of the hills. E. R. PLAISTED.

Clamp Arbors for Piston Rings

Figs. 1 and 2 show two of a set of clamp arbors for holding piston rings ranging from four to six inches diameter. These arbors are used for holding the rings while turning them to the proper diameter after the gaps are cut in them. An arbor is required for each size of ring. Fig. 1 shows the construction of arbors for rings ranging from four to eight inches diameter, and Fig. 2 shows the construction of arbors for rings ranging from nine



CLAMP ARBORS FOR PISTON RINGS

to sixteen inches diameter. Those shown are the eight- and the sixteen-inch sizes. The cores are made of tool steel and their centers are hardened. The shoulders near the dog ends have two flats milled on them to facilitate holding the arbors in a vise when placing piston rings into them. One nut is used for clamping the rings in the smaller sizes of arbors, and three or four nuts are used on the larger sizes. The stud *A* on the larger arbors is used for driving, and when in use it engages with a carrier, which is clamped to the face plate of the lathe. The clamping flanges are made of gray iron driven on the cores. The outside diameter is turned 1/16 inch smaller than the finished dimensions of the rings, and the shoulder *B* is turned to fit the smallest inside diameter of the rings when the ends are drawn together, the rings then being elliptical in shape. The movable flanges on the larger arbors contain slots at one end of which are openings which clear the washers on the studs, allowing the flanges to be removed without taking the nuts off. Two rings

are placed in an arbor at a time. Before clamping, their ends are drawn together with contracting clamps, one of which is shown at Fig. 3. The parts *C C* and *D D* of these clamps are made of machinery steel, and part *E* is made of leather. This construction allows the rings to be contracted without distorting their shape, which insures their having a perfect bearing in the cylinders when finished. When placing the contracting clamps over the rings the gap between parts *c c* must be over the gaps in the piston rings.

H. E. R. MANBRAND.

Specialist Versus the All-Round Man

I don't think "Jack and Would be Master of one Trade" quite means all he says at page 515; in fact, the way he chooses to sign himself is enough to give him away. Surely he does not think an expert lathe hand is master or ever will be of the machinist's trade as long as he hangs to a lathe. It is very easy for him to give advice about specialists, but I notice he did not altogether follow it himself during that twelve months. Suppose we were all specialists, where would the foremen come from? Or suppose an expert lathe hand decided to start a shop for himself, and found that a planer was indispensable; the first thing he knew some improver whom he hired would be showing him how to run his own machine. Jack seems to be rather well endowed with brains, and the knack of doing the right thing along mechanical lines, which many of us have to learn through longer periods of practice. I am not advising the training of all apprentices to be all-around men, but certainly there must be and is—if the business is to thrive, which it seems to be doing rather strenuously at present—a middle course. Let the specialists choose that line for themselves, but with the probable outcome that they will earn their living at a machine until the end, while the one who takes the harder course—not necessarily changing shops every month—has, I think, a better chance in the long run of doing something better for himself, both in a money way and socially if he cares for that side of life.

Everyone most naturally judges things from his own point of view and rightly so. I will give an example of a young man who came within the radius of my observation and I will leave it to Jack, or anyone else to say what course would have been best for him. He was a chap who had never got along at school and started to work in a screw-machine shop at 16 years of age. He showed up so well that in six months he was running a complicated turret screw machine. Then he quit, went across the street where they were busy enough to be working nights and hired as a lathe hand; he managed to hit the pace, at full machinist's wages, and after several months asked to be changed to a planer which had just been vacated and so on. Three years from the time he started he was a foreman of a small shop with fifty men under him. How about specializing for him?

NERALCM.

"Rifling a Pistol Barrel by Hand"—A Similar Job on a Rifle Barrel

Mr. McL's article at page 351, on rifling a pistol barrel by hand, reminded me of a somewhat similar job I once did, namely boring and rifling a rifle barrel. The barrel in question was a 22 caliber which had become so badly rusted that it was useless in its present state and not having the necessary cash to send it to the factory and get it bored I thought I would try to do the job myself. I first made a boring tool like Fig. 1, which I screwed onto a 3/16-inch rod and using a very fine feed and fast speed I made a nicely finished hole. The next job was to rifle the barrel and that proved to be a good deal harder than boring it. The rifling tool I made

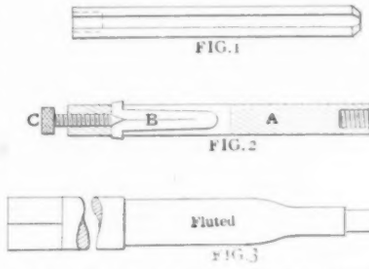


FIG. 1
FIG. 2
FIG. 3

TOOLS FOR BORING, RIFLING AND CHAMBERING A RIFLE BARREL

like Fig. 2, *A* being the body of brass turned to the same size as the bore, *B* the cutters made of a flat piece of steel about 1/16 inch thick with a hole at one end and a 60-degree V cut in the other, and then split by a fine saw from the bottom of the V to within a short distance of the pin hole, and *C* being the adjusting screw for expanding the cutters. To get the proper pitch for the grooving I twisted a piece of square steel rod with a couple of monkey wrenches to one turn in twelve inches and by pulling the twisted rod with the rifling tool fastened on one end of it, through a square hole in an iron block held stationary on the bench, the barrel also being held stationary on the bench with the bore in line with the hole in the block, I was able to make a good job of the rifling. After rifling I lapped the barrel by hand, using a lead lap and powdered glass to remove any burs thrown up by the rifling tool. I next made a chambering tool like Fig. 3, and to get the right shape and size for the tool (which was very difficult to measure on account of its shape) I took a cartridge and standing it mouth upward on the bench, poured babbitt around it, and when the babbitt had cooled I punched the cartridge out, and after easing a little had a gage to work to which enabled me to get the tool accurately to size. When the barrel was finished I tested it and found that it shot as straight as any of the barrels of like caliber turned out by the manufacturers of firearms.

T. R. H.

"Information Wanted about Journal Bearings"—An Opportunity for Our Technical Schools

Mr. Plaisted, at page 485, wants to know just a few things about bearings. What use more data would be to him I do not see. Ever since the first man built a wheelbarrow we have been experimenting with bearings. The data collected since would fill a pretty big book, but are not in shape to use. You have all heard the cook's recipe for bread. You take quite a lot of flour, sift in a lump of salt, a half a cup or so of sugar, melt a piece of lard in some water, put in a cake of yeast, put in what milk you have and fill up with water. Stir it together and bake after it rises. Do you wonder that there is excitement about the uncertainty of housekeeping?

The way we get results from our experience is just as bad. A man builds a machine. The bearings heat. He makes them longer and they heat worse. He makes them shorter and the heating stops. He doesn't discover that his shaft was bent, so he makes all his other machines like the last one. To make information about bearings of any value so as to predict what another bearing will do we must know what the conditions are. Does the shaft fit? Does it spring under load so that the bearing is really concentrated in one spot? Is the shaft round, or three-cornered? Does the box swivel or does it only look as if it would? Are both boxes in line? and so on. Such experiments can be made only in a laboratory where exactness can be obtained. The results must be taken accurately. It is not enough to say that at 500 revolutions per minute and a thousand-pound load this box was all right, but at 1000 revolutions it heated. How much did it heat in either case? For a given bearing metal, a given clearance for oil, a given oil, etc., what is the curve of velocity times pressure at which the temperature rises and keeps on rising faster than the heat radiates? I can see a whole summer's work in taking one size box with one grade of babbitt and finding out something about it.

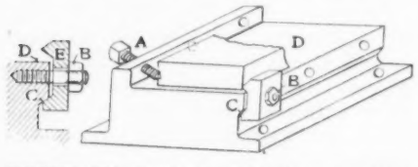
But what Mr. Plaisted really ought to do is not to collect any more uncertain data, but get our technical schools to take up the matter and then get someone to furnish the

funds to experiment with. These schools are all equipped or would be glad to equip themselves with the necessary apparatus to make such endurance tests. I have a friend who stands around in one of these schools and looks wise and draws a salary. He says that they are looking for just such practical problems but they haven't the money necessary to handle them. He says that if you go to a manufacturer to get money he will say that he has no money for boys to fool with, or if he does chip in a little money he thinks that it takes forever to get any results. My friend says on the other hand that he would be glad to oversee and guarantee the accuracy of tests himself if someone would furnish the money necessary to cover bare expenses and give him time enough to allow him to use student work.

Where students are in the laboratory only a few hours per week and have to spend a good part of their time getting started there is no such thing as hustling things along. Mr. Editor, let's stir 'em up a little and see if they cannot give up some information in shape to use. If you want a little shop theory, I should say that for a given oil, if you find out how heavy a pressure per square inch it will hold up at certain velocities, and then if you know how large a bearing you really have and how much irregularity of bearing surface your oil will take up, or compensate for, and a few other little things, you will be quite a way toward solving this problem, for as I see it, all a bearing is for is to hold up a film of oil around a revolving shaft. We ought not to allow the two surfaces to come in contact at all. ENTROPY.

Fixture for Holding Rectangular Work in the Shaper

The accompanying illustration shows a fixture for holding work of rectangular section while being shaped. It was of importance that the top and bottom faces of the work should be parallel to each other and to accomplish this rapidly this fixture was made. The work is placed on the fixture and brought to bear upon the hardened points of the inclined screws *A*. The clamp nuts *B* are then tightened,



FIXTURE FOR HOLDING RECTANGULAR WORK

causing the hardened edges of the clamps to impinge upon the work with a slight downward movement given by the angle *C* on the bottom of the clamp and corresponding angle on fixture. The inclined screws are now given a half turn, bringing the work firmly down on the face *D*. When releasing, the middle inclined screw is brought back a little farther than the other two, so that when setting up, the work bears first upon the end screws only. If necessary, fixed stops could be employed. The end view shows the clamp *E* clearly so that further explanation is unnecessary. I have seen this method of clamping employed upon other jigs and fixtures with success. The hardened edges and points mark the work, but this did not matter as the marked faces were machined afterward.

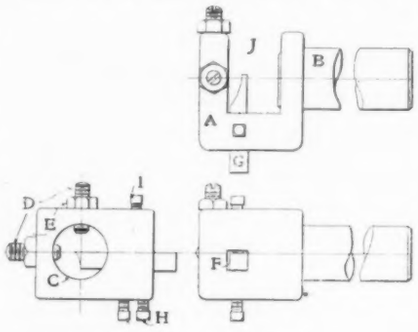
England. CHERRY RED.

A Pointing Box-tool

The illustrations show a very simple box-tool for pointing bolts, studs, etc., in the turret lathe.

The body *A* is of machinery steel. One end of it is drilled and tapped to admit the stem *B*. The stem *B* should be about five or six inches long so as to allow adjustment. It is made of machinery steel turned a good fit for the turret.

At the front end of the body *A* there is a hole *C* to admit the work that is to be pointed. The work is supported by the two tool-steel screws *D*, which act as back rests. These screws *D* are adjustable to quite a large range of diameters and do away with the annoying chang-



A POINTING BOX-TOOL

ing of bushings. After being adjusted they should be held by the check nuts *E*.

At the back of the body *A*, there is a square hole *F* to admit the pointing tool *G*. This tool *G* can be ground to form any style of point desired.

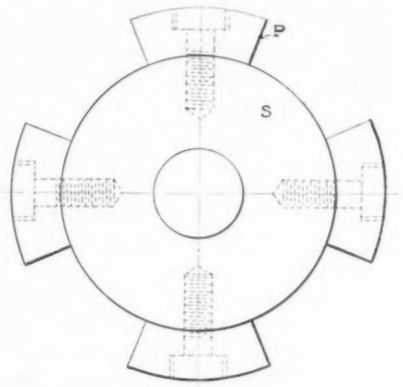
The tool *G* is set and adjusted to cut on center by the two screws *H*. After setting the tool *G* it is held in place by the screw *I*. The screws *H* and *I* are case-hardened. The opening *J* should be wide enough so as to give good clearance for chips and not allow the opening to become clogged up. ANTHONY.

Tension in Pole-piece Bolts

A great deal of discussion has been caused by the following problem, which has come up in the design of high-speed electric machines.

A pole piece *P* is bolted upon the spider *S* by several 3-inch bolts, the spider being a forced fit upon the shaft. The bolts holding *P* are set up with several thousand pounds pressure each, clamping *P* securely to *S*. The initial tension in the bolts is, we shall say, 2000 pounds per square inch, put there by the long-lever wrench.

The question is whether or not additional tension is produced in the bolts



POLE-PIECE BOLTS

when the spider is rotated—the speed of rotation being less than that which would cause a centrifugal of 2000 pounds per square inch on each bolt. I. L. D.

[The question raised is analogous to another which has been discussed several times in our columns—does steam pressure on a cylinder head add to the initial strain on the studs due to screwing up the nuts? The answer depends upon the relative elasticity of the parts. To take one extreme case—that of a perfectly elastic bolt and non-elastic pole piece—centrifugal force will not add to the strain, while in the opposite case—that of a perfectly elastic pole piece and non-elastic bolt—the two forces will be added together. The actual conditions necessarily lie between these two cases, and in any actual case are obviously obscure. Under these circumstances, the only prudent course is clearly to consider the final strain to be the sum of the initial and applied loads.—ED.].

Annealing Tool Steel

One matter which interests me very much, and I presume would interest many others, is the best method of annealing tool steel, so as to get the best results in working, and at the same time without injuring the steel by changing its toughness, and leaving it brittle after it is tempered. In my opinion this is of much importance, especially in connection with the manufacture of dies and other special and expensive tools which, as we are all well aware, are of little account if the steel has in any way been overheated either in annealing, or after the tool has been properly finished, ready for the hardening process. We know that tool steel can be purchased from the different steel companies already annealed and ready to be machined; but that does not help others who are obliged

to use material that is furnished in the unannealed state.

I am willing, at this time, to be the target for your many readers to shoot at, and hope to be benefited myself, and in an indirect way may be able to help others who perhaps are trying, without success, to get good results from unannealed tool steel.

Where I am at this time we use for our dies 16-cent Jessop steel, which comes to us unannealed. We have a Brown & Sharpe No. 2 annealing and case-hardening furnace, and another one that was designed by the company I am with, which, though not as convenient to operate, gives equally good results in annealing. We use coke for firing our furnaces, and pack our steel with granulated charcoal in sealed cast-iron boxes, keeping the fires at an even heat for about 24 to 26 hours, and then allow the furnaces to cool down so we can handle the steel, this being at about blood heat when taken from the furnaces. We harden our dies in lead, and draw the temper in oil at 480 degrees for steel-pipe dies, and 470 degrees for bolt dies. We have a thermo-element galvanometer, made by Keiser & Schmidt, of Berlin, to get our heat in the lead bath, so as not to overheat our steel for hardening, and for tempering we use an oil-hardening furnace made by the American Gas Furnace Company, of New York. We use a standard thermometer furnished by the same concern, to indicate the correct degree of heat for tempering. We can say that we are attaining good results by these methods, yet we feel that there may be some kinks both in annealing and hardening that might be of advantage for us to adopt. I have visited some of the twist-drill and special-tool manufacturing companies to see what their methods were for annealing and hardening steels; but in all cases except the Cleveland Twist Drill Company, I find they are working along about the same line that we are. What I should especially like to see discussed is the process of annealing, and whether there is any mixture for packing steel for heating that will bring the steel out in quicker time than we are making, and yet leave it soft to work and not injured in any way.

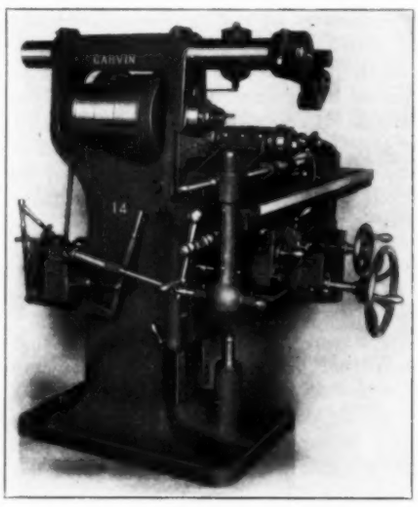
KNIGHT T. GIFFORD.

A Cam-Cutting Attachment

The attachment shown was designed for milling the flat steel cams used on gas engines. It is driven by power from the machine on which it is mounted and is automatic in action.

The spindle and its driving gear are in one piece. The work is mounted on the forward end of the spindle, and the former is doweled to the face of the worm gear on the rear. The spindle slide is mounted on its own base and is pressed up against the former pin roller by a weight and strap hanging at the rear end of the milling-machine table. The former pin bracket is adjustable and permits formers much larger than the work to be used, which conduces to accuracy, durability and easier action in climbing steep lifts.

In operation the spindle of the attachment is on a level with the cutter spindle, and the former pin stands at the same hight on the work spindle, but as the former pin is not in a fixed relation to the cutter, the work can be fed up to the cutter by means of the milling-machine slide for roughing and finishing cuts, to regulate the size of cam, etc. Formers of any size larger or smaller than the model can be developed by clamping the sample on the face of the worm gear on the spindle, and feeding the work up to the cutter until the desired diameter is obtained. This attachment can be applied to any milling machine, with the feed connection on either side of the machine, as the end bracket can be arranged to go on the front or rear end of the slide, and reaches down so that connection is made to the power feed shaft at an easy working angle. Largest diameter of cam 12 inches. This attachment is made by the Garvin Machine Company, New York.



A CAM-CUTTING ATTACHMENT

Annual Meeting of the American Society of Mechanical Engineers

The annual meeting of the American Society of Mechanical Engineers, like the meeting of last year, will be held in the auditorium of the New York Edison Company, 44 West Twenty-Seventh street, where the official headquarters will be opened Tuesday, December 4, at noon, and maintained throughout the meeting. At the opening session on Tuesday evening, 8:45 o'clock, President Fred. W. Taylor will present his address, on "The Art of Cutting Metals." This will be followed by a social reunion, during which refreshments will be served, and at which ladies will be especially welcome.

The second session will open on Wednesday morning at 9:30 o'clock, and will consist of, first, the annual business meeting, in which the reports of the council, tellers, standing and special committees will be presented. New business can be presented at this session or at the Friday morning session. This will be followed by a report of the committee on "Standard Proportions for Machine Screws," and then a discussion of the president's address of the evening before. Luncheon will be served at 1 o'clock on the floor below.

The third session, on Wednesday afternoon at 2 o'clock, will be a symposium on power plants, at which the following papers will be read: "The Evolution of Gas Power," by F. E. Junge, of Berlin, Germany; "Producer Gas Power Plant," by J. R. Bibbins, of Pittsburg, Penn.; "Steam Turbine Characteristics," by Hans Holzwarth, of Hamilton, Ohio; "A High Duty Air Compressor," by Prof. O. P. Hood, of Houghton, Mich.; "Design of an Improved Boiler Setting," by A. Bement, of Chicago; "The Steam Plant of the White Motor Car," by Prof. R. C. Carpenter, of Ithaca, N. Y.

Wednesday evening is unassigned.

At the fourth session, which will commence at 10 o'clock Thursday morning, the following papers will be presented: "Saw-tooth Roof Construction," by F. S. Hinds, of Boston, Mass.; "Ferroinclave Roof Construction," by A. E. Brown, of Cleveland; "Saw-tooth Roofs for Factories," by K. C. Richmond, of Providence, R. I.; "Weights and Measures," by Henry R. Towne, of New York.

On Thursday afternoon at 2 o'clock an excursion will be held over the new electrically equipped lines of the New York Central & Hudson River Railroad, making a start from the Grand Central station.

At 9 o'clock on Thursday evening a reception will be held at Sherry's, Forty-fourth street and Fifth avenue.

The closing session will be held at 10 o'clock Friday morning, and the following papers will be presented: "A Mechanical Engineering Index," by Prof. W. W. Bird and Prof. A. L. Smith, Worcester, Mass.; "Ventilation of the Boston Subway," by H. A. Carson, of Boston, Mass.; "Flow of Fluids in Venturi Tubes," by E. P. Coleman, of Buffalo, N. Y.; "Tests of an Elevator Plant," by A. J. Herschmann, of New York; "Tests of a Rotary Pump," by Prof. W. B. Gregory, of New Orleans, La.; "Improved Transmission Dynamometer," by W. F. Durand, of Stanford University, Cal.; "A Plan to Provide Skilled Workmen," by M. W. Alexander, of Lynn, Mass.

In our account of the meeting of the Society for the Promotion of Industrial Education we said that among the other speakers on that occasion would be Jane Addams, of Hull House, Chicago. The printers made it James Addams.

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Coal-Mine Explosions Connected with the State of the Barometer

An interesting and perhaps important suggestion is made by F. W. Parsons in The ENGINEERING AND MINING JOURNAL to the effect that a fall in the barometer, by showing a reduced pressure of the atmosphere which naturally increases the flow of gas from the coal seams into the workings of mines, may indicate danger periods as regards explosions. Mr. Parsons has selected at random a number of recent explosions of gas and compared them with the Government Weather Bureau records of the state of the barometer, and he finds that in every case the explosion occurred while the barometer was falling. He gives a diagram wherein the readings of the barometer are averaged and the time of the explosion noted, and the result seems almost a demonstration of his theory. He suggests that the Weather Bureau forecast the movements of low barometric areas for the benefit of mining men in order that action may be taken to safeguard coal mines at these danger periods.

The Advancing Wage

Referring to the announcement that next year the Postmaster General will recommend a general advance in the wages of postal employees of all grades, such recommendation being based upon the allegation that the cost of living has doubled since the present rates of wages were fixed, and that competent men cannot be retained in the service at present rates, one of our leading newspapers comments upon the matter apparently with the idea that wages are the only element of cost in production. It says: "Beyond any question when everybody gets more pay, everybody will inevitably find that the same amount of money will not buy as much as it did before. The vicious circle comes in here, as in so many other places, and those whose interest in economic problems is confined to getting the greatest possible elevation of their own wages first and of other people's next, are condemning themselves to some grievious disappointments in the future." Authorities recognize three factors in the production of wealth—land, labor and capital. By the recent very great increase of the value of franchise corporations, of mineral lands, urban and suburban property it is made evident that the first factor among those mentioned is getting a very largely increased share of the proceeds of production. The four hundred millions of dollars agreed to be paid by the U. S. Steel Corporation to James J. Hill is evidence along that line. While it is true that a general rise in wages is likely to increase the cost of production and, therefore, increase prices, it by no means follows that when everybody's wages have been raised workers will be no better off than before; it may mean simply that workers, i.e., all those actively engaged in useful productive occupations, have managed to get a somewhat larger share of the joint results of the employment of the three factors mentioned.

At this writing railroad employees seem likely to get a general increase and many of them have already received it. It is well known that the salaries of men competent to carry heavy responsibilities in manufacturing establishments have been greatly advancing of late. Such men seem to be increasingly scarce relative to the demand for them and we now hear of salaries even well above $20,000 a year paid to men who a few years ago would have expected $10,000 to $12,000. True this is due partly to the growth in size of industrial establishments and to the increased responsibilities to be carried, but it is also due in part to the general recognition of the fact that a higher standard of living and of expense of living now prevails. Of course such salaries are not paid simply upon demand, but they are paid willingly enough to those who have demonstrated their ability to "make good."

Russian Railway Time-tables

One of our railroad contemporaries has reproduced some pages of a Russian railway time-table and commented rather facetiously upon the use of symbols throughout the table, indicating points where refreshments are to be obtained, and where stage and steamboat connections are made. Thereupon one of our bright newspaper men comments upon the matter as follows:

"Russian railways do not generally occur to the mind as a type of the highest excellence, either in equipment and service or in methods of management. But in some details it would appear that they can give points to the world. For example, a reproduction of a page or two of the official Russian railway guide reveals the naive and charming way in which the railway managers indicate to the unlettered traveler the information for which he will 'thirst' as to the opportunities for refreshment. Symbols take the place of printed notes in the time-table, and the selection of a cocktail glass as the instrument most frequently associated in the Russian mind and practice with such incidents of travel, and the frequency of the intervals at which the symbol appears in the list of stopping places, are touching revelations of Russian habits and of the kindly consideration of Russian railway officials. In like manner the introduction of tiny cuts of prancing ponies or conventional boats suggests graphically stage or river transportation connections, information only second in importance to

that which has to do with the glass aforementioned."

As a matter of fact the use of these pictures is quite consistent with the common practice in Russia. We have shown in our columns exterior views of machinery stores in Moscow and St. Petersburg having upon their exteriors painted pictures of lathes, milling machines, planers, etc., and in Russian cities one constantly sees all over the fronts of stores, pictures of the merchandise on sale within. It is a Russian custom. The use of pictures in a time-table does seem rather odd to those who are unaccustomed to it, but imagine a Russian who has been accustomed to getting his information regarding refreshments, points of connections, etc., from the time-table itself as he glanced over it, attempting to derive from a page of an American railway guide such information by means of the symbols usually employed in our own publications of that nature. These, instead of giving the weary searcher the information he desires at once and concisely, merely inform him first that if he will look somewhere at the bottom of the table, or at the end of the book, or on the next page, he will find similar marks and then the legend after such similar marks will tell him what the first marks mean. We imagine that this would appear to the Russian to be far more absurd than his own method, and who shall say that he would not have good reason for thinking so?

Graft at San Francisco

As if the ordinary forms of graft are not disgusting and discouraging enough, we now have what seems to be almost conclusive evidence to the effect that there has been considerable graft in the distribution of the money contributed for the benefit of the San Francisco earthquake and fire sufferers, and indictments have been brought against some of the officials who are accused of diverting such funds to their own use. Scoundrels who steal from such a fund as this not only harm those who contribute the money and the intended beneficiaries of it, but they injure all who may be the victims of future similar catastrophes, because occurrences such as this undoubtedly have a strong deterrent effect upon those who would contribute for such purposes. People are usually willing to contribute to the help of unfortunate brothers suffering from such a catastrophe as was the San Francisco earthquake, but they do not like to contribute their money when they have reason to believe that even a portion of it will be stolen; and it is probable, therefore, that the men who have stolen from the San Francisco fund are in reality thereby inflicting additional and needless hardship upon sufferers by future calamities of a similar nature.

ORGANIZATION OF THE SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION

In accordance with the previously announced program the above named society met in New York City for organization on the afternoon of the 16th of November, at which meeting general officers and a board of managers were elected, with the exception of the secretary, who is to be elected by the board of managers at its first meeting, to be held within a month of the organization meeting.

THE EVENING MEETING

The meeting in the evening filled to overflowing the large hall of Cooper Union. Prof. Milton P. Higgins, of Worcester, Mass., opened the proceedings, giving first a history of the inception of the idea of such an association and dwelling at some length upon its importance, and the urgency of the work it may do. He announced that, owing to the ill-health of Dr. Henry S. Pritchett, he was unable to be present as had been expected, and that, therefore, Dr. Nicholas Murray Butler, president of Columbia University, would preside.

DR. BUTLER SPEAKS

Dr. Butler upon taking the chair alluded to the fact that no hall in America could more appropriately be used for the organization of such a society than the one in which the meeting was then being held. For forty years or more, he said, the most distinguished speakers and leaders of thought in America had met in this temple of industrial education to discuss the things most interesting to American citizens; while in the rooms above the auditorium there met daily during the season thousands of students pursuing studies related to the industries of the country. He expressed the opinion that whatever else might be said of the recompense of labor, if labor were made worth more it would be sure to get more, and the way to make it worth more was to increase the intelligence with which labor is performed.

MR. VANDERLIP SPEAKS ON OUR FOREIGN TRADE

Frank G. Vanderlip, of the National City Bank, was then introduced as the first regular speaker. His address was based largely upon statistical information of which the speaker has made a specialty, and particularly that which relates to our foreign trade.

The speaker said that last year the United States had exported to the markets of the world two billion dollars' worth of commodities. Of this, seven hundred million dollars' worth had been manufactured goods; but, he said, none, or practically none, of this had been sold in foreign markets on account of the superior handicraft entering into its manufacture. It had been sold in foreign markets, he declared, mainly on account of our superior natural resources, the enterprise and organizing ability of our business men, the large scale upon which they carried on manufacturing operations, the inventive ability which led to our larger use of automatic and labor-saving machinery than was used elsewhere, all contributing to costs that were the despair of our competitors. But he stated emphatically that practically none of these manufactured products had been sold abroad on account of superior hand skill; a statement which possibly might be disputed by a good many builders of machinery, especially machine tools, into which skilled handiwork does and always must largely enter. The speaker gave it as his opinion that the advantage of labor-saving machinery is quickly dissipated by the adoption of such machinery by foreign manufacturers, and it seemed to be his idea that every other advantage we possess can be easily acquired by our competitors except the handicraft, which we are yet to acquire. He attributed Germany's recent rapid advance in the manufacturing arts to her system of technical and industrial education and believed that the problem of the unemployed, which is now so prominent in England, was due to England's neglect of such educational work; a statement which, needless to say, is also vigorously denied.

FREDERICK P. FISH. EFFECT OF INDUSTRIAL EDUCATION UPON CITIZENSHIP

Frederick P. Fish, of Boston, president of the American Telephone and Telegraph Company, delivered a thoughtful address in which he dwelt particularly upon the ultimate effect of superior technical and industrial education. He believed that this is not really a material question, but that it effects ultimately and in an important degree those interests of citizenship and of the nation which are not material in their nature, but far above material interests.

The speaker believed that conditions generally might be anything but desirable, notwithstanding the highest and most complete technical and industrial education; and that, in all such work, the fact should be kept in view that the ultimate object of it should be, and must be, the improvement of the individual. He believed that this education should be for the common run of men, the others being already provided for, and he thought that, as regards its effects upon our political and social relations, honesty of purpose, based upon accuracy of observation, would be instilled by such industrial edu-

cation as was proposed to be promoted by the new association.

ALFRED MOSELEY ON AMERICAN EDUCATION

Alfred Moseley, of England, addressed the audience, not, as he himself said, as an educationalist, but as one who had observed the effects of education. He had been asked what had turned his attention to America, and in reply he said that when he had been in South Africa, interested in mines, and the mines had been poorly managed and unsuccessful, he had seen American mining engineers come into the field and convert these unsuccessful mines into eminently successful ones. He had naturally asked himself what influences had given these American engineers their high degree of common sense, executive ability, initiative and other qualities necessary to make them in every way successful where others had failed. He had made up his mind that at the first opportunity he would visit this country, and for himself see, so far as possible, what had brought these things about. He believed he had found one of the chief causes in our system of public schools, which develop initiative and the reasoning powers of their pupils.

He contrasted the former industrial conditions, when industrial establishments were much smaller than now, with the present conditions, in which large establishments prevail, and in the course of his address stated that it had been said, upon good authority, that in Great Britain today there were 13,000,000 people on the verge of starvation. Mr. Moseley referred, in most appreciative terms, to the great Peter Cooper, founder of the institute in which the meeting was being held, and expressed the belief that were he alive today, he would be especially gratified at the steps then being taken for the enlargement of his ideas, and the spread of industrial education.

REPRESENTATIVE OF UNION LABOR

Samuel B. Donnelly, secretary of the Building Trades Labor Organization was introduced as a representative of the labor side of the question, and in his address most heartily indorsed the new organization and its objects. He referred to the great change that had taken place in the manner in which industries are carried on, and also to the rapid using up of our natural resources, referring to a time when as a boy he had studied a geography, having in it a picture of Iron mountain, Missouri, and being told that in this one mountain was enough iron to supply the country for many years. Recently he had traveled through that country and had found this mountain to have been entirely demolished and used up years ago, and other deposits of iron ore, thought at one time to be practically inexhaustible, are now also gone. He believed that this waste of our natural resources would have to be checked, and that we must learn to make our living in other ways than by such rapid destruction of what nature has given us.

Referring to the criticism which had been called forth by John Mitchell's statement to the effect that the American working man had largely made up his mind always to be a working man, he said that probably Mr. Mitchell had in mind particularly the mining industries, and yet Mr. Mitchell had recently most heartily indorsed a correspondence-school system, a large share of whose work is the education of miners to enable them to better their condition. And Mr. Mitchell had stated that he had known of many instances in which miners had been benefited by that system of instruction. The speaker referred to the fact that antipathy had been shown by organized labor to some trade schools and believed there was good reason for it. Nevertheless he believed that a large share of what he called the "rag-time production of America" was because American workmen know nothing of theory. The best mechanics employed by the railroads today, he said, were in the repair shops; if they were closed down, it would result in the paralyzation of our railroad systems within two weeks. He said the supply of mechanics fit for such work was entirely inadequate. He wished the new organization the greatest possible success. His address was warmly applauded by the audience.

THE HEAD OF HULL HOUSE

Miss Jane Addams, of Hull House, Chicago, was the last speaker, and she dwelt eloquently and impressively upon the human side of industrial education. Her heart is evidently filled with pity for those victims of the modern industrial system who are tied to the continuous repetitive doing of one certain thing—a small part of the production of the complete article—and who perform their tasks with little or no knowledge of the underlying principles upon which it is based, or of the nature or uses to which the final structure is put. She rejoiced that in Germany it had come to be recognized that "human welfare is a legitimate object of governmental action," and she believed that the key to success in industries is to inform the mind of the worker. She thought it might be that we had speeded up our machinery all that is possible, that men generally are working as hard as it is possible for them to work, and preserve their health. If this were so, then she believed that we must apply intelligence to our industries: the mind of the worker must be freed and applied to his work; the taste of the public must be educated to demand things which are expressive of the mind and the skill of the worker. A picture painted by half a dozen different men would be of no interest, because a picture must be expressive of the intelligence and the ideas of the artist who painted it, and she questioned whether a large share of England's industrial difficulties might not be due to the fact that for generations her artisans had been largely employed in making knives and other appliances for the use of savages. She believed that their condition today would have been much better had they been more generally ministering to the wants and tastes of highly civilized peoples. A part of that spirit which enters into the play of the children must, she declared, be enlisted in our industrial occupations. Work in manufactories must be made interesting to the workers, and there must be opportunity for individual expression. She believed this could be done and asked where else it could be better done than in this great demooracy.

THE CONSTITUTION

The constitution of the society, which had been adopted at the organization meeting, provides that all persons interested in industrial education are eligible to membership; that members shall be divided into four classes, namely: Members, who pay annual dues of $2; Sustaining Members, who pay annual dues of $25 or more; Life Members, consisting of those who pay the sum of $250 or more; and Honorary Members, those who have achieved special distinction in promoting industrial education and who are to be elected by unanimous vote of the board of directors.

The board of managers consists of a president, vice-president, secretary, treasurer and 24 additional members, eight of whom are to be elected annually to serve for a term of three years. A meeting of the society is to be held annually at such time and place as the executive committee shall decide, and the board of managers are to meet at least twice a year. From this board of managers an executive committee is formed, which is to meet once a month except during the summer months. The society is to be incorporated under the laws of the State of New York, so that it may receive donations and legacies and hold real estate and other property as a corporate body.

INTEREST AND ATTENDANCE OF MACHINERY MANUFACTURERS

Manufacturers generally, and particularly manufacturers of machinery, are taking considerable interest in the new educational association, and at the organization meeting the National Association of Machine Tool Builders was represented by President Woodward, of Worcester, Secretary Montanus, of Springfield, Ohio, Fred A. Geier, of Cincinnati, and Fred L. Eberhardt, of Newark, N. J.

OFFICERS AND BOARD OF MANAGERS

The following officers and board of managers were elected.

President:

Dr. Henry S. Pritchett, President Massachusetts Institute of Technology.

Vice-president:

M. W. Alexander, General Electric Company, Lynn, Mass.

Treasurer:

V. Everit Macy, New York City.

Managers:

Miss Jane Addams, Hull House, Chicago, Ill.

W. W. Atterbury, General Manager Pennsylvania Railroad.

Elmer E. Brown, Commissioner of Education.

Henry Bruere, Secretary Bureau of City Betterment, Citizens' Union of the City of New York.

E. P. Bullard, Bridgeport, Conn.

Frederick P. Fish, President American Telephone and Telegraph Company.

Dr. James P. Haney, Director of Manual Training, New York City.

Milton P. Higgins, President Norton Company, Worcester, Mass.

William D. Huber, President National Brotherhood of Carpenters and Joiners.

Anthony Ittner, National Association of Manufacturers, St. Louis, Mo.

Mrs. Mary Morton Kehew, Boston, Mass.

F. J. McNulty, Grand President International Brotherhood of Electric Workers.

Fred J. Miller, Editor AMERICAN MACHINIST.

Leslie W. Miller, Principal Pennsylvania Museum and School of Industrial Art, Philadelphia.

John Mitchell.

Charles A. Moore, New York City.

Mrs. C. B. Mumford, Richmond, Va.

James P. Munroe, Munroe Felt and Paper Co., Boston, Mass.

W. H. Pfahler, Philadelphia.

Charles R. Richards, Teachers' College, New York City.

Louis Rouillion, Director Franklin Union, Boston, Mass.

F. W. Singer.

Frank A. Vanderlip, New York City.

Charles F. Warner, Principal Technical High School, Springfield, Mass.

Robert A. Woods, Director South End House, Boston, Mass.

Walter M. Woods, Y. M. C. A., Chicago, Ill.

J. Ernest G. Yalden, Superintendent Baron de Hirsch Trade School, New York City.

A new concern seems to have entered the field of competition in supplying projectiles to the United States Government, and has recently put in bids at $25 each for six-inch projectiles, as against $43.25, the bid of the Bethlehem Company and $41.60 by the Midvale Company. The new concern is the Firth Stirling Steel Company, which is said to be building a plant near Washington at Geisborough Point. The company also bid on 12-inch shells at $190 apiece, as compared with $328 by the Bethlehem Company and $346.70 by the Midvale Company. It has so far proven impossible to entirely shut out competition in the making of such things as armor plate sheets, etc., wanted by the Government.

Notes on the Automobile—Motor Buses and Other Heavy Vehicles—Rubber Tire Difficulties and Spring Wheel Suggestions—What Motive Power shall be Used?

BY W. H. BOOTH

It is not possible for an observant man to move about London and not notice the steady increase in the number of vehicles which are propelled by mechanical means. It is not even necessary to believe that the vehicles at present visible are commercially successful. Information on this point is not freely published, and what is published is contradictory. It is sufficient to be able to grasp the significance of the motor bus to be able to perceive that it has a future, even if in its present-day form it may not be an unalloyed success. To see one of these buses move is to be convinced of its power. It moves as though it had a purpose in the world; it swerves nimbly out of the straight course, and circumnavigates a slow and lumbering horse-drawn wagon, and despite its giant size, it is agile as a hansom. If it has a fault it is that it moves forward so bent upon its journey's end that would-be passengers fail to attract attention, and are left lamenting on the curb.

MACHINE-PROPELLED VEHICLES NECESSARILY HEAVY

It may be laid down almost as a law of mechanical engineering that no machine-propelled vehicle on the common roads can be a success unless it be heavy. There is a sort of fatality about light machinery. Let the bicycle be taken as an illustration. In the wide world there is no such instance of lightness and strength as the man-propelled bicycle. It is one of the most marvelous adaptations of material to a desired end that has ever been made. But add to it a petrol engine, and at once how it gains in weight! For larger vehicles weight is still more disproportionately great in the case of the mechanically propelled car, and any attempt to cut down the weight of parts is likely to be a failure. It is just this weight that is at the bottom of all the difficulties in regard to tires of which so much is heard.

TIRE TROUBLES

The pneumatic tire of the bicycle runs many miles before it is worn out; but tires are the one great source of expense with large motor cars, which goes far toward confining their use to the wealthy. But such cars do use pneumatic tires. These tires, however, are not practicable for the heavy goods vehicles, nor for the motor bus. No pneumatic tire would run under so heavy a load. Solid india-rubber tires have instead to be employed, and with all the constructor's skill, they are far from satisfactory, either in price or durability. Yet it would so far appear almost imperative to interpose some elastic medium between the road and the car. What is therefore required, if the expense of india rubber is to be avoided, is some efficient substitute in the shape of a wheel with metallic springs within it.

SPRING WHEELS FEASIBLE ON PAPER

An india-rubber tire becomes very hot when at work. The kneading to which it is subjected produces internal friction within the body of the material, and the tire will frequently become hot to the point of bubbling or smoking. On paper it is a very easy matter to design a steel wheel with internal springs that will work with perfect satisfaction—again on paper. This problem of the spring wheel is one of many years' standing with the makers of heavy traction engines.

Many spring wheels have been invented, numbers of them have been tried. All, or nearly all, have failed.

LIMITATIONS OF STEEL AND OTHER SPRINGS

A steel spring has only a limited life; it will only bear, before breaking, a certain limited number of flexions. Some wheels, apparently of sound mechanical design, fail from dirt and grit. A spring composed of a block of india rubber inclosed in a supporting metal cylinder might be expected to endure. But india rubber has its limits even when thus supported. The whole problem in fact bristles with difficulties. It is urged that all these difficulties would be eliminated by the use of a perfect road surface on which truly circular wheels of steel would run without shock.

PERFECT ROAD SURFACES

But what is the tramway with its heavy steel rails, but a piece of hard, level, perfect road? Can a tramcar be taken as an altogether satisfactory type of vehicle? True, it uses a solid steel wheel free from springs, but as a vehicle it is a standing and flagrant example of the excessive weight of self-propelled vehicles. But enough has been said to point out the difficulties of one portion of the problem.

Let it be granted that a solution be found in the provision of a perfect road surface such as might be secured if the whole surface were laid with slabs of cast iron, or steel; there are other problems which must be solved; problems which indeed will solve themselves in course of time. One of the chief of these is that of motive power.

THE QUESTION OF MOTIVE POWER

At present there are before the public, at least before the technical portion of the public, some five methods of vehicular propulsion by mechanical means. These are electricity, steam, petrol, heavy oil and gas.

Electricity by means of storage batteries may be employed for private vehicles on smooth roads and is employed already in London for broughams.

Steam raised by coke fires is used for goods wagons. For motor cars steam raised by petrol in flash boilers has been found efficient. Steam raised by heavier paraffin oils is employed by the Clarkson Company. Petrol used in internal-combustion engines is at present the most common source of power. But heavy, cheap, crude oils may be employed with motors of the Diesel type, and finally gas engines, supplied by cylinders of compressed gas may be employed. Thus there is a very wide field to choose from.

SOMETHING TO BE SAID FOR EACH TYPE

Each power has its own particular advocates. Ingenuity is being expended on each and the final success of one or more agent will be determined by various factors. For goods vehicles the cost of the motive power will carry weight, while the rich man will pay little heed to cost in the hunt for convenience and cleanliness. Everything is yet chaotic in the automobile business. Types are by no means yet permanently fixed, though long strides have been made toward a fixed external form.

For purely city work on hard, smooth street surfaces the electrical brougham is already a success within the narrow range occupied by the fashionable physician or the successful actress. The great field awaiting the car builder is that of the man of moderate means who would pay £100 for a car if he could therewith secure a reliable car capable of doing 15 miles per hour and not too tiresomely slow up hill. He does not desire to scorch and will not desire anything beyond the solid rubber tire.

CRUDE-OIL FUEL ADVOCATED

To fill the demand of this large class the efforts of the steam-car builder might be very well directed in the way of a car to use cheap crude oil for steam raising and not costly petrol. Petrol costs perhaps 9 pence or a shilling (18 to 24 cents) where crude oil costs three halfpence or twopence, while the Diesel type of motor if it could be applied to a motor car would still further reduce the cost of running a thousand miles.

The automobile vehicle is still in a transition state of uncertainty, but it has come to stay and it is the machinist who has got to do much of the figuring to make it a success.

London, England.

Personal

Charles J. Mesta, vice-president of the Mesta Machine Company, of West Homestead, Penn., was recently elected to represent his district in the Pennsylvania legislature.

J. W. Parker, formerly with the Becker-Brainard Milling Machine Company, has resigned to become a partner in The Norfolk Machine Company, of Hyde Park, Mass.

E. D. Whipple, for some time past superintendent and designer at Coe Manufacturing Company, Painesville, O., has resigned to take a position with the Grant-Lees Machine Company, of Cleveland, O., in charge of one of its departments.

Boynton W. Piper, who has had charge of the metal-pattern department of the General Electric Company's works at Lynn, has resigned to become a partner in The Norfolk Machine Company, Hyde Park, Mass., manufacturers of metal patterns.

F. H. Brown, of the Brown-Zortman Machinery Company, Pittsburg, informs us that he has disposed of his interest in that company, and retired from connection with it. He has not as yet decided what he will do in the future, but may invest some capital in a machine-tool manufacturing business, his wide acquaintance with that business making such a course more probable than any other.

James B. Taylor, Jr., has tendered his resignation to the Navy Department as master steel maker, in charge of the Tropenas steel-casting plant at the Navy Yard, Brooklyn, N. Y., to accept a position with the Illinois Steel Company, Chicago, Ill. Mr. Taylor was formerly in charge of the steel-casting plant of the Newport News Shipbuilding and Dry Dock Company, Newport News, Va.

W. S. Leonard, who for some years has been instructor in practical machine design and machine-shop work at the Michigan Agricultural College, Lansing, Michigan, has been obliged as a result of failing health to give up his position and go South. He writes us from Edgewood Station, Atlanta, Georgia, that, owing to an error of the railway company his household goods went astray and that much of his time since arriving there, October 4, has been spent in trying to locate the goods and in getting settled. He has not as yet determined what work he will take up.

Business Items

The Hydro Press Company, Rochester, N. Y., has purchased the rights and good will of The J. T. Schaffer Manufacturing Company, to manufacture hydraulic presses of every description. They have increased the facilities of the old plant and made improvements in the design of the presses.

Manufacturers

The Leominster (Mass.) Button Company will erect a new factory.

The Brown Truck Company, Omaha, Neb., will erect a larger factory.

The Fall River (Mass.) Bobbin and Shuttle Company will build an addition.

The Minneapolis (Minn.) General Electric Company will enlarge its plant.

The Grand Rapids (Mich.) Hand Screw Company will erect a new plant.

Finnessy & Kohler, wagon builders, Philadelphia, Pa., will erect a new factory.

The Slade Mill Company, Portland, Ore., will expend $60,000 in additional improvements.

The New Hampshire Electric Company, Salem, N. H., is to build a three-story addition.

The Mattatuck Manufacturing Company, Waterbury, Conn., brass goods, will enlarge its plant.

The Foote Manufacturing Company, Nunda, N. Y., making cement mixers, is erecting an addition.

The Hart Manufacturing Company, Hartford, Conn., electric supplies, will erect a new plant.

The American Foundry and Machine Company, Dubuque, Iowa, will erect an addition to its plant.

William Goodrich & Co., Milwaukee, Wis., will erect a new linseed-oil plant, to cost about $100,000.

A new boiler house is to be erected for the Barre Wool Combing Company at South Barre, Massachusetts.

The Walker Marine Fittings Company, Port Jefferson, N. Y., is planning the erection of a factory building.

The Hamblin & Russell Manufacturing Company, Worcester, Mass., will erect a new engine and boiler room.

Plans have been filed for the erection of a new boiler house at W. H. Shepherd & Sons' mill, Wilkesbarre, Pa.

The R. H. Pollock Canning Company, of Baltimore, Md., will erect a $15,000 canning plant in Richmond, Va.

Catalogs

Gisholt Machine Company, Madison, Wis. Bulletin describing method for finishing automobile fly-wheel. Illustrated.

Graham Manufacturing Company, Providence, R. I. Circulars illustrating and describing universal jig vise for drills and drill speeder.

De La Vergne Machine Company, foot East 138th street, New York. Folder describing Klein water-cooling tower. Illustrated, 6x9 inches, 4 pages, paper.

Lancaster Forge and Blower Company, Buffalo, N. Y. Folder No. 28, describing forges, blowers, drills, punches, shears, etc. Illustrated, 7x6½ inches, 20 pages, paper.

Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. Circular No. 1139, describing starting and field rheostats. Illustrated, 7x10 inches, 19 pages, paper.

The Pittsburgh Automatic Vise and Tool Company, Pittsburgh, Pa. Catalog describing "Pittsburgh" automatic double and single swivel vises. Illustrated, 4x6½ inches, 28 pages, paper.

Narragansett Machine Company, Providence, R. I. Catalog of steel and wood lockers. This contains lists of stock sizes, description of parts, locks, benches and other accessories. Illustrated, 6x9 inches, 32 pages, paper.

E. W. Bliss Co., Adams and Plymouth Sts., Brooklyn, N. Y. 1906 catalog of presses, dies and special machinery. This is a voluminous book containing a number of new machines. Illustrated, 5½x8 inches, 578 pages, cloth.

Miscellaneous Wants

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad St., New York.

Wanted—Medium-weight specialties to build. Box 326, AMERICAN MACHINIST.

Universal Test Indicator circulars free. H. A. Lowe, Lock Box 146, Cleveland, O.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machry. to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Dies and Diemaking, $1.00. A shop book by a shop man. J. L. Lucas, Bridgeport, Ct.

Novelty in tool or machine specialty wanted. Particulars required. Box 202, AMER. MACH.

Special machinery designed and built. Walter S. McKinney, M. E., 43 Broadway, Flushing, N. Y.

Tools, dies and special machinery built by contract. Chas. Crabb Co., 635 Kent avenue, Brooklyn, N. Y.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Gas engines designed to order. Marine and automobile work a specialty. H. L. Towle, 150 Nassau street, New York.

Boston architect or engineer desiring to divide office, telephone and stenographic expenses. Address Box 331, AMER. MACHINIST.

Wish to place contract for yearly supply of gray-iron castings, similar to gas-engine castings; about four tons daily. R. X. Y., Box 283, AMERICAN MACHINIST.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Special high-grade machinery built to order. Automatic and otherwise; electrical work a specialty. Complete modern equipment. Automatic Machine Development Company, 130 East 12th street, New York.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Draftsmen, engineers, graduates, designers, learn automobile designing, including the latest European and American practice; day and evening classes, and by correspondence; write or call for prospectus. Favary's Automobile Designing School, 1416 Broadway, New York.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

Inventor of line-centering device that every engine builder should have for his erectors, if accuracy of initial installation is desired, wishes to negotiate with parties for the development of invention. The device is patented in the United States (Patent No. 831,862) and Canada, and other applications are being prepared. This set of tools has been seen and highly praised by several practical engineers, who predict great success when it is put on the market. In order to secure necessary capital, the owner will sell the patent rights either for cash or on the basis of manufacturing and marketing the device on a royalty. This is an excellent opportunity for private parties; or for a firm already manufacturing small tools to increase its line by the addition of the new tool set. All communications should be addressed to Box 45, Nanaimo, B. C., Canada.

Business Opportunities

Good mechanical engineer wanted by ornamental and structural iron works; must buy interest; old established; highest references. Box 346, AMERICAN MACHINIST.

Wanted to contract with shop within 50 miles of New York City, equipped for making highest-grade automobile chassis. Must have capacity for at least 100 cars per year and able to do highest grade interchangeable work cheaply. No body work. Box 210, AM. MACH.

British agency—A firm of engineers, with works and warehouses in west of England, London offices and agents throughout Great Britain and Ireland, are open to accept sole agency for American specialties in engineers' tools, etc. Address Frederick Avens & Co., "Trusty" Engineering Works, Stroud, Glos., England.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the construction of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

Wanted——Capital to start manufacturing patented automatic drill chuck; no wrench or key or spanner, no more stopping of the machine; the drill will be inserted in full speed; no turning in your hand; everything safe; this saves time, labor and money and keeps the drills in first-class condition. An automatic drill chuck of great merit. Would consider proposition of a firm desiring to add new line of manufacturing under partnership or company, or will sell out whole patent. Patented in the United States and foreign countries; copies on hand. Inventor, George Rothenbücher, 183 Alabama ave., Brooklyn, N. Y.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—AMERICAN MACHINIST, 1902—05 inclusive, $5. Box 340, AMER. MACHINIST.

For Sale—Two second-hand cupolas in first-class condition; shells 72"—82" in diameter and about 40 feet high. Box 333, AM. M.

For Sale—One 1½" head Acme bolt cutter, complete set of dies for cutting from ½" to 1½", United States standard thread, countershaft; all in good condition; price reasonable. Box 348, AMERICAN MACHINIST.

For Sale—Four new extra heavy and well made gasolene engines; can readily be used for gas; price $150. These cost $275 each. One new No. 3 Goulds rotary pump, 5-inch suction, $90; cost $135. Geo. Gorton Machine Co., Racine, Wis.

Wants

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Inventor (33), now employed, wants to change; typewriter or similar work preferred. Box 339, AMERICAN MACHINIST.

NEW JERSEY

Mechanical engineer, 20 years' experience general design, will be open for engagement Jan. 1. Address Box 297, Glen Ridge, N. J.

NEW YORK

Mechanical engineer, competent, experienced man, with some capital, seeks business opportunity. Box 302, AMERICAN MACHINIST.

PENNSYLVANIA

Position as superintendent or works manager by young aggressive hustler; wide experience handling men and work; will guarantee results after investigation of proposition; at present in charge of large gas-engine plant; sufficient reasons for desiring change; can furnish good references. Box 338, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted — Toolmakers experienced on fixtures, dies and gages. Applicants should give age, experience and wages expected. Ross Rifle Co., Quebec, Canada.

CONNECTICUT

Wanted—First-class operator on Jones & Lamson turret lathe; also one first-class all-around machinist. The New Machine Co., Danbury, Conn.

Wanted—Tool makers, die sinkers, drop forgers and men familiar with grinding machines. Apply to D. P. Beckwith, Pope Manufacturing Company, Hartford, Conn.

ILLINOIS

Wanted—A man of first-class ability as designer of intricate machinery and with some experience in charge of draftsmen; knowledge of jigs and fixtures preferred; concern is rapidly growing and the opportunities for advancement are unusually good; location is in a desirable residence city within 100 miles from Chicago. Box 344, AMER. MACHINIST.

Wanted—A man between 30 and 40 years of age who has had charge of a large number of men on small machine work of the very finest character, and who can show a first-class record in such work, together with reliable references as to character and ability, and who desires to make a change with a view to bettering his position. Those interested are requested to send a brief account of training and experience, together with a statement of nationality, age and salary expected, to the address given below. All communications considered strictly confidential and returned to writer if requested. Box 343, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted — Draftsmen on boiler supplies, tools, etc.; state age, experience and salary required. Apply to The Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Mechanical draftsman for special work, involving machine designing and shop systematizing; $2000 per year. Write Y. M. C. A. Employment Department, Springfield, Mass.

Wanted — Competent draftsman and designer, with experience in handling men, for position with machine shop; salary $1500 to $1800 per year, depending on experience. Apply to Box 345, AMERICAN MACHINIST.

An assistant superintendent for an iron foundry and machine shop employing about 350 men; must have good executive ability and be familiar with methods that produce results; state age, references, synopsis of experience and salary expected. Box 314, AMERICAN MACHINIST.

A machine shop employing 300 hands, with enlargements under construction, is looking for a man to have immediate charge of the drafting room and do designing of a complicated character; a technical education, followed by some years of practical experience, with a first-class record, is required. Box 341, AMERICAN MACHINIST.

Wanted—A man thoroughly competent to act as assistant superintendent of an up-to-date machine shop, employing 500 men, on accurate, interchangeable work; concern is rapidly growing and prospects of advancement are excellent for the right man; the location is an ideal residence place, having most of the advantages and few of the disadvantages of a large city. Box 342, AMERICAN MACHINIST.

MICHIGAN

Wanted—Toolmakers; three or four first-class men accustomed to high-grade work; sewing machine or typewriter men preferred; steady employment to competent men; state experience and wages wanted. Address Metal Sectional Company, Benton Harbor, Mich.

Wanted—Screw-machine man, one who can set up Brown & Sharpe automatic and hand screw machines and make himself generally useful in a screw-machine department; we guarantee a steady position to a competent man; state age, experience and wages expected. Address Metal Sectional Company, Benton Harbor, Mich.

MISSOURI

Wanted—Machinists, electricians, engineers and firemen, do you want to "get wise?" Send for 52-page pamphlet containing questions asked by different Examining Boards; sent free. Geo. A. Zeller Book Co., 53 South 4th street, St. Louis, Mo.

NEW HAMPSHIRE

Wanted—A draftsman experienced on machine tools; state experience and wages expected. Address Flather & Co., Inc., Nashua, N. H.

NEW JERSEY

Several first-class tool and diemakers accustomed to high-grade work; steady employment and good wages to competent men. Sloan & Chace Mfg. Co., Sixth avenue and Thirteenth street, Newark, N. J.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Master mechanic for a machine shop with a well established business; a young, educated, experienced and thoroughly up-to-date man; only those who state age, nationality, experience, references, salary expected, etc., with full particulars, will be considered; growing business and an opportunity for the right man. S. A. E., AMERICAN MACHINIST.

NEW YORK

Wanted—Experienced men on general tool work. Box 299, AMERICAN MACHINIST.

Wanted — Experienced draftsmen, toolmakers and machinists; give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Wanted — Competent millwrights; applicants will state wages expected and when they can commence work. Address A. A. P. C. W., Alsen, Greene Co., N. Y.

At our new factory—Toolmakers experienced in fine and complicated work; steady employment and good wages. Jones Speedometer Co., New Rochelle, N. Y.

Technical men everywhere in spare time. No goods to sell; no expense; professors, draftsmen and literary machinists thus far appointed; state experience. Box 334, AM. M.

Draftsmen on jigs and fixtures for duplicating work; none but experienced men wanted; good pay for right men. Mergenthaler Linotype Co., 20-42 Ryerson St., Brooklyn, N. Y.

Wanted—Mechanical and electrical draftsmen. Apply, giving age, experience and salary expected. Engineer in Charge, Drafting Department, General Electric Co., Schenectady, N. Y.

Engine erectors wanted; those experienced with internal combustion engines and gas producers preferred; state experience and salary. De La Vergne Machine Co., foot East 138th street.

Man wanted to represent us on the road; one acquainted with babbitt, solder and type-metal trade and preferably employed at present. This is a good opportunity for the right party. Box 266, AMERICAN MACHINIST.

Wanted—First-class lathe and horizontal boring mill hands on night shift, first-class floor hands day shift; no labor troubles; increasing force. Address, stating wages desired, Ingersoll-Rand Co., Painted Post, N. Y.

Wanted—By large manufacturer of electric hoists and cranes, a first-class erector who has had charge of important work and had several years' experience; write, stating age, experience and salary desired. E. C., AM. M.

Wanted—Foreman in machine works, manufacturing woodworking and other machinery; must be thoroughly competent, with executive ability, who knows how to handle men and tools to best advantage; state age, experience and salary expected. Box 324, AM. MACH.

OHIO

A man competent to take charge of tap and die department may learn something interesting by addressing Box 308, AMER. MACH.

Several first-class draftsmen, thoroughly familiar with steam-hammer designing; state experience, age and salary expected. Box 301, AMERICAN MACHINIST.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

General foreman wanted for machine shop handling high-grade engine work; about 200 men; advise fully regarding experience and salary; excellent opening for right man. Box 347, AMERICAN MACHINIST.

Wanted—Mill draftsmen for architectural department, accustomed to making layouts for machinery and power departments; also high-class designing draftsmen for light machine tools, etc. Address, giving age, salary expected, etc., Box 337, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted — Draftsman on high-grade engine work. Box 332, AMERICAN MACHINIST.

Wanted—Superintendent for machine shop building hoisting engines, and general work; small shop. Box 325, AMERICAN MACHINIST.

Wanted—Department foreman for gear-cutting plant; must have experience. Address with full particulars, Box 320, AMER. MACH.

Wanted—Ten machinists, general machine and bench hands; also two A-1 patternmakers. Apply to Scottdale Foundry and Machine Co., Scottdale, Pa.

Wanted—Experienced operator for Jones & Lamson lathe; steady work in a good town. Write Wilson Laundry Machinery Company, Columbia, Lancaster County, Pennsylvania.

Wanted—Machinist and diemaker, also superintendent who can handle men to advantage and get maximum product at minimum cost; manufacturers of hardware and wooden ware specialties. Address "Ely," AM. MACH.

Wanted—Lathe foreman capable of producing good work at minimum cost for growing shop now employing forty (40) hands; good opportunity for the right man. Wilson Laundry Machinery Company, Columbia, Lancaster County, Pennsylvania.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections, these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

VIRGINIA

Salesman—We wish to engage a good, live man having knowledge of the machinery and supply business; one familiar with the trade in North and South Carolina preferred. Address Box 335, AMERICAN MACHINIST.

WISCONSIN

To cope with the continuous enlargement of our business, first-class machinists, patternmakers, molders and boilermakers can find steady employment. Box 899, Milwaukee, Wisconsin.

Wanted—For accurate gear cutting, a competent man who will instruct and supervise, also operate machines on automobile work; open shop; good surroundings. Thomas B. Jeffery & Company, Kenosha, Wis.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

WEST OF MISSISSIPPI

The J. Geo. Leyner Eng. Wks. Co., of Littleton, Colo., are increasing their plant and are in need of good mechanics, machinists, blacksmiths and sheet-iron workers. Littleton is a suburb of Denver, where cost of living is reasonable; superb climate the year round. Address above.

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Prentiss Tool & Supply Co., New York.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Athol Machine Co., Athol, Mass.
Hammacher, Schlemmer & Co., New York.

Calipers

Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams

Boston Gear Wks., Boston, Mass.

Carborundum

See Grinding Wheels.

Castings, Brass and Bronze

Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Chicago Foundry Co., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Hopson & Chapin Mfg. Co., New London, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.
Veeder Mfg. Co., Hartford, Conn.

Castings, Malleable

Bancroft & Co., Philadelphia, Pa.

Castings, Steel

Bancroft & Co., Philadelphia, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Chicago Foundry Co., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.
New England Steel Casting Co., Hyde Park, Mass.

Cement, Cast Steel

Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Machine Co., D. E., New London, Conn.

Centers, Planer

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Wks., Boston, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., The, Columbus, Ohio.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold

Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines

American Tool Works Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cushman Chuck Co., Hartford, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Scott & Sons Co., Medford, Mass.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer

National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split

National Tool Co., Cleveland, O.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.

Clutches, Friction

Caldwell, Son & Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Wood's Sons Co., T. B., Chambersburg, Pa.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Coils

Standard Welding Co., Cleveland, Ohio.

Compounds, Pipe Joint

Dixon Crucible Co., Jos., Jersey City, N. J.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Boston, Mass.
Bury Compressor Co., Erie, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Mietz, August, New York.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas

Ingersoll-Rand Co., New York.

Condensers

Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.

Conduit, Interior

Sprague Electric Co., New York.

Cones, Friction

Evans Friction Cone Co., Boston, Mass.

Connecting Rods and Straps

Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Mach. Co., Boston, Mass.
Chapman & Co., J. B., Springfield, Mass.

Controllers and Starters, Electric Motor

Case Mfg. Co., Columbus, Ohio.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Coping Machines

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Long & Allsatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Cork Inserts

National Brake & Clutch Co., Boston, Mass.

Correspondence Schools

See Schools, Correspondence.

Cotters

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.

Countershafts

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders' Iron Fdry., Prov., R. I.
LeBlond Mach. Tool Co., R. K. Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Cresson Co., Geo. V., Phila., Pa.
Gisholt Mach. Co., Madison, Wis.
Speed Changing Pulley Co., Indianapolis, Ind.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cresson Co., Geo. V., Phila., Pa.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkesbarre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes

Alliance Machine Co., Alliance, O.
Brown Hoisting Mach. Co., New York.
Case Mfg. Co., Columbus, O.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, Ohio.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines

Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts

Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles

Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers

Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas and Ladles, Foundry

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil

Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Elliott Chemical Works, Newton, Mass.
Lunkenheimer Co., Cincinnati, O
Winkley Co., Detroit, Mich.

Cups, Grease

Lunkenheimer Co., Cincinnati, O.

Cut Meters

Warner Instrument Co., Beloit, Wis.

Cutters, Milling

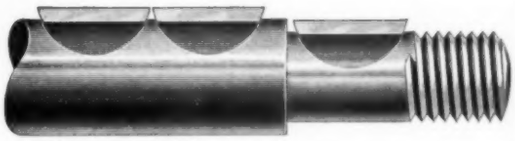
Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.

NOVEMBER 1st, 1906.

OCTOBER 1st, 1906.

AUGUST 1st, 1906.

This will be Headquarters for HIGH-GRADE DRIVING CHAINS, THE WOODRUFF PATENT SYSTEM OF KEYING and HAND (FEED) MILLING MACHINES.



We will commence to move into our new fire-proof factory building this month and will operate both plants, old and new, until we are fully settled in our new quarters, so our production will not be decreased.

The Whitney Mfg. Co.,

Hartford,

Connecticut.

Cutters, Milling—*Continued.*

Ingersoll Milling Mach. Co., Rockford, Ill.
International High Speed Steel Co., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Fawcus Mach. Co., Pittsburg, Pa.
Hill, Clarke & Co., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Machine Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Cutting-Off Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.

Diamond Tools

Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Boston Tool Co., Cambridge, Mass.
Kent & Co., Edwin R., Chicago, Ill.
Wade Machine Co., Boston, Mass.

Dies, Sub-Press

Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening

Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Mach. Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.
Scott & Sons Co., Medford, Mass.

Dowel Pins

Winkley Co., Hartford, Conn.

Drawing Boards and Tables

Obermayer Co., S., Cincinnati, O.
Queen & Co., Philadelphia, Pa.

Drawing Materials

Queen & Co., Philadelphia, Pa.
Soltmann, E. G., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines

Universal Drafting Mach. Co., Cleveland, O.

Drift Bolt Drivers

Ingersoll-Rand Co., New York.

Drilling Machines, Bench

American Watch Tool Co., Waltham, Mass.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Dwight Slate Machine Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Boiler

American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote, Burt & Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Multiple Spindle

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.

Drilling Machines, Portable

Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial

American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford, Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fairbanks Co., New York.
Fitchburg Machine Works, Fitchburg, Mass.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Ridgway Mach. Tool Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Drilling Machines, Turret

National Separator & Machine Co., Concord, N. H.
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Fairbanks Co., New York.
Fenn Mach. Co., Hartford, Conn.
Fosdick Mach. Tool Co., Cincinnati, O.

Drilling Machines, Upright—*Continued.*

Foote, Burt & Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center

Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.

Drills, Hand

Cincinnati Electrical Tool Co., Cincinnati, O.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Pneumatic

Chisholm & Moore Mfg. Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Foote, Burt & Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Curtis & Curtis Co., Bridgeport, Conn.
Hisey-Wolf Mach. Co., Cincin., O.
Parker Co., Chas., Meriden, Ct.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock

Ingersoll-Rand Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.

Drying Apparatus

Boston Blower Co., Hyde Park, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Eck Dynamo & Motor Works, Belleville, N. J.
Electro Dynamic Co., Bayonne, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.

Dynamos—*Continued.*

Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies

Clark, Jr., & Co., Jas., Louisville, Ky.
Electro Dynamic Co., Bayonne, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Elec. Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery

American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., & Co., Jas., Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Hisey-Wolf Mach. Co., Cincin., O.
U. S. Electrical Tool Co., Cincinnati, O.

Elevators

Albro-Clem Elevator Co., Philadelphia, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.
Morse, Williams & Co., Philadelphia, Pa.

Emery Wheels

See Grinding Wheels

Emery Wheel Dressers

Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Heald Machine Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room

Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineers, Consulting and Mechanical

Dodge & Day, Philadelphia, Pa.

Engineers, Electrical

Crocker-Wheeler Co., Ampere, N. J.

Engines, Automobile

Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Reeves Pulley Co., Columbus, O.

Engines, Gas and Gasolene

Automatic Mach. Co., Bridgeport, Conn.
Blaisdell Machinery Co., Bradford, Pa.
Foos Gas Engine Co., Springfield, Ohio.
Foss Gasoline Engine Co., Kalamazoo, Mich.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Jacobson Mach. Mfg. Co., Warren, Pa.
Mietz, August, New York.
New Era Gas Engine Co., Dayton, O.
Olds Gas Power Co., Lansing, Mich.
St. Marys Mach. Co., St. Marys, Ohio.
Struthers-Wells Co., Warren, Pa

Engines, Oil

Mietz, August, New York.

Engines, Steam

Boston Blower Co., Hyde Park, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

NEW SHOPS OF THE CINCINNATI MACHINE TOOL COMPANY

A City Shop of Modern Construction and Good Architectural Appearance

EDITORIAL CORRESPONDENCE

At page 790, Part 1, of the present volume, we mentioned the character of the work being done by the Cincinnati Machine Tool Company in building their drill presses, and remarked that we hoped soon to have the opportunity of presenting an account of their new shops, in the arrangement of which it is apparent that considerable gray matter has been employed.

AN ACUTE-ANGLED CORNER AND ITS TREATMENT

For reasons which need not be considered here, this shop is not built where space is limitless, but stands upon a plot of city property, which is not rectangular in shape but is as shown in the plan, where it may be noticed advantage is taken of the acute angle of the corner to arrange the building so that from each office room better lighting and better circulation of air are obtained than would be possible with the ordinary arrangement. In other words, each of the three rooms along the front of the building is a corner room and the arrangement is much superior in every way to the ordinary plan of simply running the wall along parallel to the street line in an attempt to utilize all the space.

LIGHTED FROM ALL SIDES

This leaves the shop space rectangular and, at the opposite end, as will be noted, there is a brick-paved driveway 12 feet wide, so that the building has windows on all sides and is well lighted, this lighting being helped by white interior painting.

CASTING DELIVERY AND STORAGE

This concern, following the general practice of the tool builders of Cincinnati, has no foundry of its own, but contracts for its castings. When these castings arrive, as they do on trucks, they are brought into the yard and are lifted from the truck and lowered into the "casting storage" by means of an electric jib crane attached to the side of the building and by means of which a casting may be placed at once in any desired position.

The "casting storage" is a walled pit with concrete floor which is on a level with the floor of the basement, from which there is access to the elevator. The latter is motor driven and is surrounded entirely by brick walls. At the main floor,

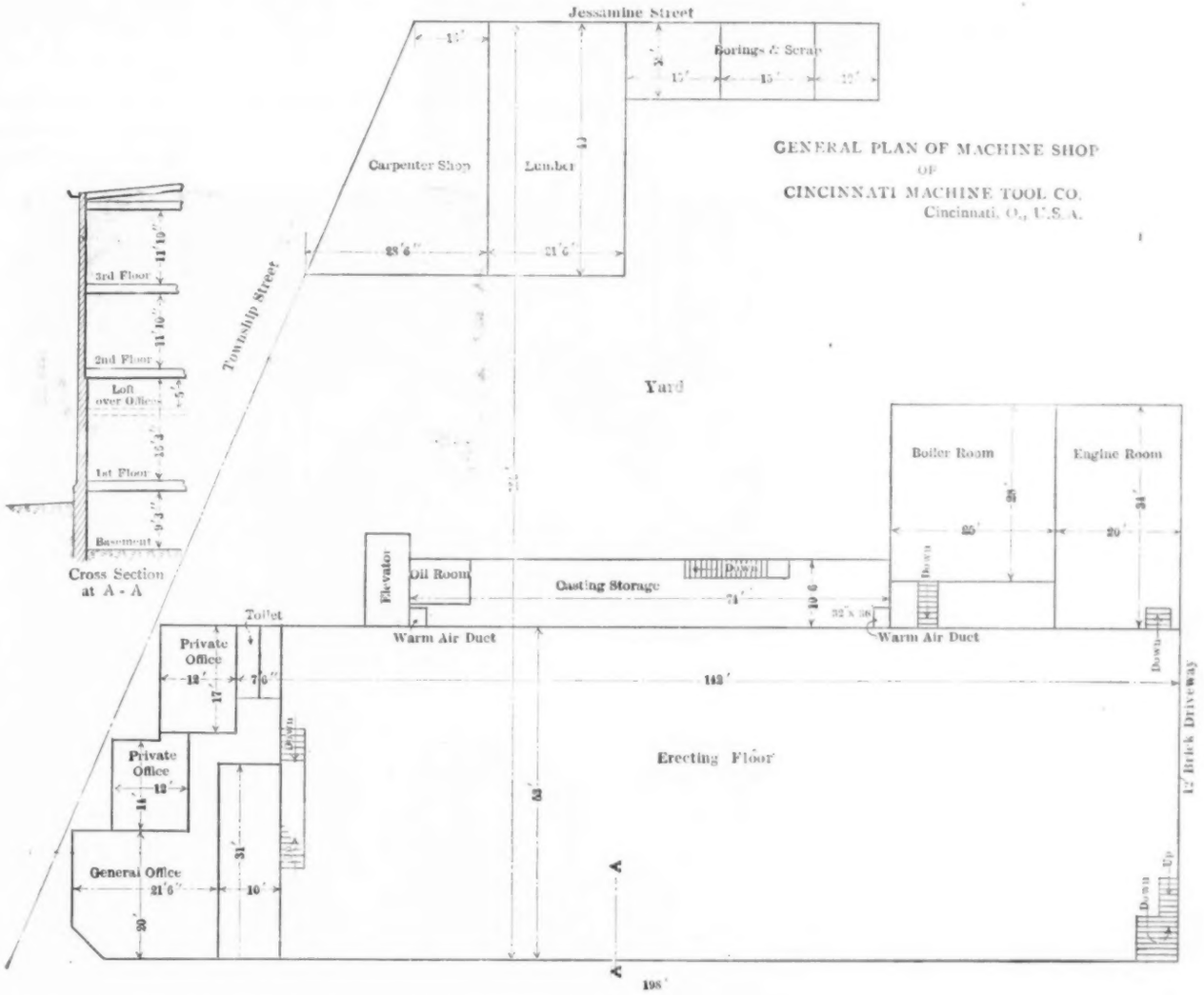


FIG. 2. GENERAL VIEW OF NEW SHOP OF CINCINNATI MACHINE TOOL COMPANY

where there is more or less of handling of heavy machinery and goods in and out (the elevator being directly accessible from trucks standing in the yard as well as from the shop floors), there is what may be called an air lock so arranged that it need never happen that doors opening to the outer air be open except when other doors are closed, so as to prevent cold east winds from blowing into the shop in winter time. It is common to have zero weather in Cincinnati and open doors while loading or unloading machines counteract lots of expensive heating.

POWER PLANT

The boiler and engine rooms are shown at the right, the transmission from the engine to the shafting being by electric current from a 250-h.p. Greenwald-Brown-Corliss engine and Jantz & Leist generator, the group system of driving being employed.

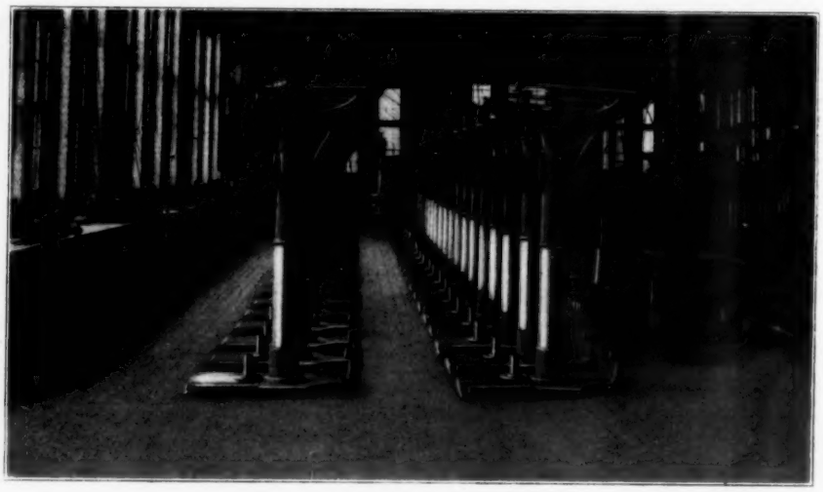


FIG. 4. PART OF FIRST FLOOR USED FOR ERECTION OF 21-INCH DRILLS. FORTY LINED UP READY FOR INSPECTION

FIG. 3. VIEW OF SHOP FROM REAR, SHOWING ENGINE ROOM, ELECTRIC CRANE, ETC. THREE-STORY BUILDING AT LEFT IS PART OF NEIGHBORING PLANT

The shop is heated by the American Blower Company's system of hot-air circulation, the location of the vertical hot-air ducts being indicated in the plan, and one of them appearing also in Fig. 3.

CEILING HIGHT AND A STORAGE LOFT

It will be noticed that the lower floor ceiling is high (16 feet 3 inches), this head room being considered necessary in the shop; but as in the offices such high ceilings were not considered desirable, a loft has been arranged above them, which is used for storage of jig and special patterns, etc. This loft is lighted by the small windows seen over the office windows in Fig. 2. The drafting room and pattern shop are on the floor above and at the same end of the building, so that they share the advantages of lighting, etc., already referred to.

THE MAIN FLOOR

The main floor is divided lengthwise into three bays, each covered by a traveling crane. On this floor are the heavier tools, all of which are placed upon masonry foundations, extending below the basement floor. The floors are of two-inch tongued and grooved pine, over which is laid one-inch tongued and grooved maple flooring.

At each end of the building is an iron stairway extending from the basement to the top and on each floor are lockers, wash and toilet rooms for employees.

The upper floor space is occupied by the smaller machine tools and the tool room.

The building is of red brick with white stone trimmings, and the entrance to the offices is of white glazed brick. Though architectural effect has not, of course, been the main consideration, it is gratifying to note that some attention has been paid to it, and the building looks well aside from its strictly utilitarian value. We understand that although an architect was employed, the credit of the planning is mainly due to Messrs. Tuechter and Schauer, in charge respectively of the commercial and the mechanical divisions of the business.

Some Pattern-shop Experiences—The Possibilities of Saving Time on Various Jobs—Patterns Made by Apprentices and Others

BY J. L. GARD

Many mechanics are rather sensitive about being told just how to do their work, seeming to look upon it as a reflection on their ability for the boss to go into detail as to just how it should be done. In patternmaking I've seen more time wasted by men that could not grasp the essentials of construction of a particular job, than was necessary to do it. Finding the way is half doing the job, but these men resent the best way being found for them. It is refreshing to meet a workman that is willing to do a job in a better way than he has thought of, and do his best that way. I have known men to leave a job with the remark that they "wouldn't work for that cranky boss; he wants to tell me everything and doesn't think I've learned the trade." They did not seem to realize that the boss wasn't anxious to tell them unnecessary things. These thoughts are introductory to a pattern-shop incident.

TIME ESTIMATING ON PATTERNS

The boss patternmaker had taken on a new man a few days before a lot of drawings came in for some automobile patterns, on which they wanted an estimate. The new man had said when asking for a job that he had done this class of work, so it occurred to the boss that it might be well to get his opinion on the time needed to make them. After looking over them himself and making up his own estimate he took them over to George, the new man, and told him to look them over carefully and make a list of the pieces and the time he thought it would take to make each one, and bring it to the office. The two estimates were compared and were found to vary on different parts, but the total difference was about 15 per cent., the boss guessing the lowest. On some parts the boss was lower, and on some higher. A bid was sent in that was an average of the two estimates and it brought the job home.

FIG. 5. WEST SIDE OF ERECTING FLOOR. THIRTY 24-INCH DRILLS

FIG. 6. CENTRAL SECTION OF ERECTING FLOOR. HEAVY TOOLS AT FAR END

MAKING A PATTERN QUICKLY

George was making some patterns on a previous lot when this occurred and the boss thought that some of them could have been done quicker and wanted to help get the next lot through at a better profit which he thought he could do if he could get George to take more detail directions and yet he wanted him to see that it was possible to do so, without reflecting on his ability, for he was a good workman. Selecting a small piece which George thought would take two hours to make while the boss thought one hour would do he went to George's bench and said to him, "George, I think if this is handled right my time estimate is enough and to spare, and I want to make my opinion good; just take your watch and see how much time I put on it." It was necessary that the boss take a small job, as he could not expect to complete a large one on account of the frequent interruptions that came to him. After the boss completed the piece he took it and the drawing to George and told him to check it up and also note the time, which was 25 minutes. George brought it back and remarked, "that is a swift way to make that piece," and then showed two slight errors, which, while not enough to condemn the job, left it imperfect. So the boss said, "I'll make another, watch the time again." This was turned over to George to check up and note the time. George said he'd "pass this one," and the time was 21 minutes. So counting both of them 46 minutes, the boss had made good by 14 minutes.

COÖPERATION BETWEEN PATTERNMAKER AND FOREMAN

He then asked George what he thought was his object in doing this. He didn't know. Then the boss explained how he wanted him to see that the way a thing was done counted for more than working hard, and then said: "George, we've got this job to make as much as we can out of, and while I don't expect you to work any harder, and am not questioning your ability, I want you to make these patterns my way, and do your best on them; if you see a better way than mine, let's talk it over. If you make them in better time than we figured, you are helping me; and if I show you ways to get a result in less time, and you profit by the showing, I'm helping you to be worth more; and you know to get more we must be able to command it. I want my help to get more here than is in the pay envelope, and I appreciate anything they can do for me. Now let's work together." Had the boss insisted on his way without backing up his opinion, George would have felt differently about it; but he readily saw the result, and the job went along nicely.

AN APPRENTICE IN THE PATTERN SHOP

An apprentice was given a boss to fit on an irregular piece that needed to be a drawback, and it was down in the mold. After much effort and trouble he finally got it fitted on and nailed. The foreman came around to inspect the job and said: "Why, you have nailed this on; how is the molder to get that out of the sand?" This puzzled the kid at first, but after

thinking about how hard it was for him to get it on, he said: "Let the molder attend to that; I have had enough trouble to get it there."

Another time he had completed a job and had it half varnished, when the boss came around and told him he had failed to sandpaper it. At a loss for an excuse, the kid began to look at the drawing, and brightened up with the remark that "the drawing didn't call for sandpapering."

A JOB-SHOP PATTERN

In a job shop a transient came in for an estimate on a pattern. The proprietor said he would make him one for $14 or one for $10. The customer thought that even $10 was too much, so the boss said: "I will make you one for $5; now what kind of a pattern do you want; a 5, 10 or 14 dollar one?" The customer decided a $10 one would do him and left the job. The boss took the drawing to one of his men and told him to make the job; "but Mike, don't use any rule on it; just make it look like that."

A CHEAP PATTERN THAT WAS "LOST"

This was the boss that made a pattern for a penurious gentleman who, after reducing the estimate from $15 to $8 left the job, from which he wanted twelve castings. The pattern was completed and delivered; upon the customer asking for a suitable place to have it cast, the patternmaker sent him to a nearby foundry. Having occasion to visit this foundry the next day, the patternmaker chanced to see the pattern among some that he had come after and took it home with him. Going for his castings the next day the customer found that they had made only eight, and he must have twelve. Not being able to find the pattern, and the foundryman disclaiming any responsibility for its loss, he started for the patternmaker to get another made. He tried to tell him that he ought to make another cheaper, as the molder had probably burnt up the other, but the patternmaker said that he had made the other too cheap, and he must have $10 for another one. This he said he could have ready in the morning, if the customer would leave a deposit of $5 on the job. After many protests he finally left the money. During the day the patternmaker got out the original pattern, smoothed it up and revarnished it, and next morning collected from the gentleman the other $5, and sent him away very unhappy over having to get two patterns.

A GEAR PATTERN AND A SHRINK RULE

A new man that had got into the pattern shop from a cabinetmaker's job found it very hard to grasp the mysteries of the shrink rule. Having a gear to make, the drawing for which called for 30 teeth, he made it with 31 teeth. The error passed the patternmaker foreman, and the gear went through the machine shop and was put into the machine, where, the pitch not being right, the teeth broke out. The boss patternmaker, upon looking over the pattern before making another casting, discovered the extra tooth. When he asked the maker of it what that extra tooth was put in for, he replied that it was for shrinkage, and seemed surprised that it wasn't right.

A Filing Machine

This machine was designed for filing and sawing dies and similar work. The saw takes the place of the tedious drilling operation for roughing out, and by keeping closer to the outline leaves less work for the file. The machine filing takes the place of hand filing. All the operator has to do is to guide the work, the machine reciprocates the file, gives the correct clearance and, by means of an attachment, the work is held down on the table against the return stroke of the file. Fig. 1 shows the machine in position on the bench with the operator filing a piece of work. Between the operator's hands may be seen the holding-down attachment, the finger of which bears on the work in front of and close to the cutting face of the file.

FIG. 1. THE FILING MACHINE IN OPERATION

The tang of the file is held as shown at Fig. 2. The small, spring-actuated, centering cup at the top holds the end of the tang, while two setscrews on opposite sides hold the tang lower down. The setscrews are in a collar which is held on the spindle by a setscrew. When changing files the collar and file are removed together, and another file—with collar attached—is substituted. As six of these file-holding collars are supplied with the machine, quite a variety of files may be ready for immediate use.

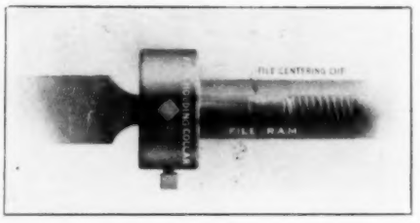


FIG. 2. FILE-HOLDING DEVICE

The lower end of the file is held against the thrust of the work by an adjustable rawhide roller, which is mounted underneath the table. This roller is held in place in its bearings by two small clips, and can be easily removed when it is desired to replace it with the steel roller used with the hack saw, or jewelers' saw.

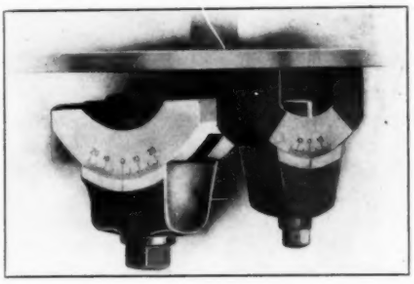


FIG. 3. TABLE-TILTING ARRANGEMENT

The table tilts to an angle in any direction. Fig. 3 shows the tilting device. The graduations to the right are on a part cast integral with the table. The part under this graduated part is in one piece with the graduated arc to the left. The part underneath the graduated arc to the left is an extension from the arm for the table.

The table of the machine can be raised or lowered in an instant by the toggle lever shown in Fig. 4. In this way, internal work may be disengaged from the file for inspection or other purposes. To the left of the table in Fig. 4, is shown one of the adjustable fingers for holding the work down against the return stroke of the file.

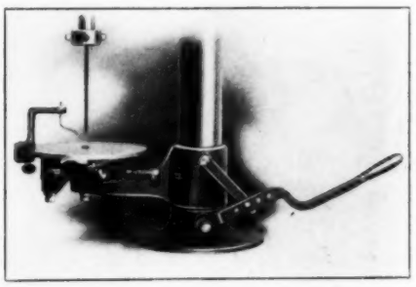


FIG. 4. THE TABLE LOWERED BY TOGGLE LEVER

The slotted disk, shown at Fig. 1, provides means for adjusting the length of stroke. In this view the table is shown in working position, locked by the toggle lever. The machine is supplied with all the accessories described, and with one wrench which fits all the adjustment nuts. It is made by the Simplex Manufacturing Company, 140 Nassau street, New York.

French inventors have been making 10-franc pieces, it is stated, by forcing melted crystal into molds and plating the coins thus formed with gold. Their weight and ring are exactly like those of the genuine coins, but they are brittle and easily smashed.

A NEW FRENCH OPTICAL HIGH-SPEED GAS-ENGINE INDICATOR

Inertia Eliminated. Cards Taken at 2000 Revolutions per Minute

We present herewith a brief description of a highly interesting indicator for extremely high speeds, which is the invention of MM. Hospitalier and Charpentier and the product of the Société Alsacienne d'Electricité of Strasbourg, Germany. The usual mechanisms of the pencil movement and paper drum are eliminated, their places being taken by a flexible diaphragm and a ray of light. The mechanism is located at one end of an elongated box, at the opposite end of which is a sheet of ground glass over which a dot of light travels and marks out the diagram. Fig. 1 shows the general construction, the ground glass being at *a* and the mirror at *b*. At *c* is a small acetylene lamp, a ray from which is reflected by a totally reflecting prism *d* to the mirror. This mirror is mounted on three points, one of which, at the right-angle apex of a right-angle triangle, is stationary, while the others at the other angles of the triangle are attached to the piston-motion reducing mechanism and the pressure diaphragm respectively. The actions of the piston motion and the cylinder pressure are thus to tilt the mirror in directions at right angles to each other, the motions being compounded as they are transmitted by the beam of light which traces the well known form of the indicator diagram on the ground glass.

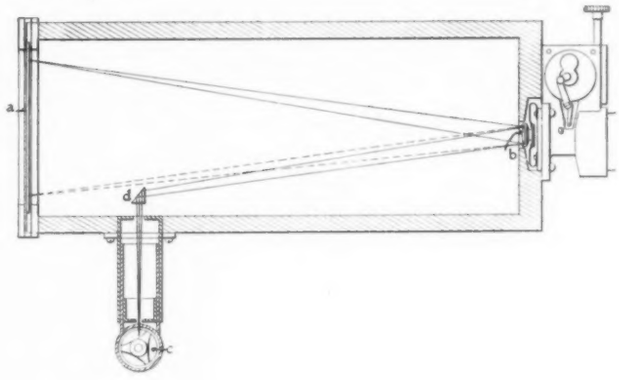


FIG. 1. A FRENCH OPTICAL INDICATOR

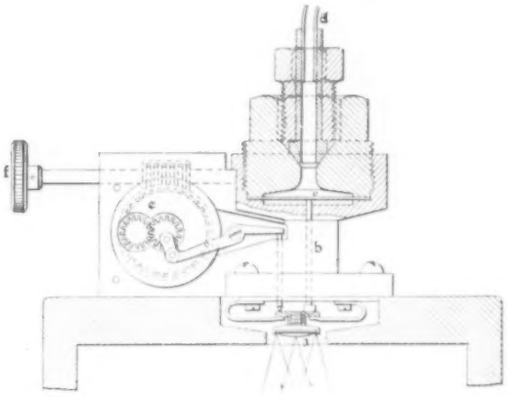


FIG. 2

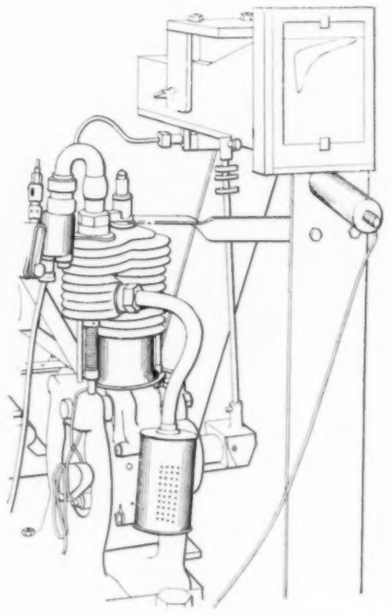


FIG. 3. THE INDICATOR IN USE

A section of the mirror end of the instrument is shown in Fig. 2. The mirror appears at *a*, a rod *b* connecting it to the pressure diaphragm *c*, the rear side of which is connected to the interior of the cylinder by the small copper pipe *d*. The cylinder-reducing mechanism is shown at *e*, though its action is not entirely clear. The shaft of this mechanism is connected with the shaft of the engine by a universal jointed connection, and to permit the adjustment to agreement of the zeroes of the piston and reducing mechanism, a planetary gear, worm gear and nurled head *f* are provided. This adjustment is especially useful when indicating multiple-cylinder gasolene engines, as by it the adjustment may be made for the various cylinders without disconnecting the apparatus.

The flexure of the diaphragm is not proportional to the pressure, but this is corrected in the diagram by making the end of the rod on which the mirror rests a curved surface, by which the point of support is made to vary with the position and the displacement of the mirror is made proportional to the pressure.

The appearance of the instrument as applied to a small gasolene engine is shown in Fig. 3.

The instrument has been successfully used at speeds of 2000 revolutions per minute. The persistence of vision is not sufficient to permit the eye to see the diagram as a closed figure unless it is completed in less than a tenth of a second, and, as the complete diagram corresponds to two revolutions of an internal-combustion engine, this involves a speed of at least 1200 revolutions per minute. To obtain a closed diagram at slower speeds or to obtain a permanent record at any speed, the ground glass is replaced with a photographic plate on which the ray of light leaves its record as a complete card. Fig. 4 is a reproduction of the two such photographic records for which, together with the information from which this article has been prepared, we are indebted to the Société Anonyme Westinghouse, Havre, France.

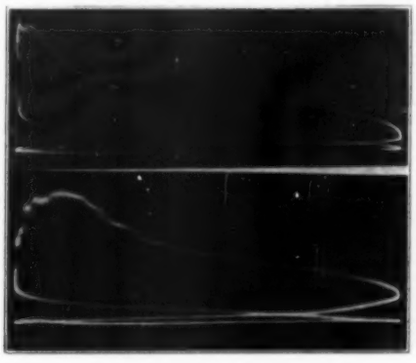


FIG. 4. CARDS TAKEN WITH THE OPTICAL INDICATOR

The use of aluminum wire has made feasible the dispensing with the insulation in winding magnets for moderate potentials, the natural oxide on the surface of the wire providing sufficient insulation. Wet paper is put between the layers when the potential exceeds 200 volts, and for still greater potentials the wire is dipped into a chemical bath to increase the amount of oxidation.

COMPLETE GRAPHICAL SOLUTION OF SPIRAL GEARS

All Problems Solved Without Mathematics

BY E. H. FISH

The realization that to many men, whether in the shops or drafting room, the use of formulas containing trigonometry or calculus is irksome, whether the one using them never knew or has only forgotten, has led me to put together the following graphical methods of solving problems relating to spiral gears. I have followed the work and problems given by Mr. McCabe at page 498, not because I think these methods better than his, but to make it plain that such problems are susceptible of solution by this method, as well as by the analytical. So far as accuracy is concerned, if these diagrams are laid out carefully double or four times full size and scaled immediately, before the paper has time to shrink or swell, they will give sufficiently accurate results for all purposes.

PRINCIPLE OF THE METHOD

In Fig 1, $A\,B$ and $B\,C$ represent the axes of two gears at 90 degrees. The lengths $A\,B$ and $B\,C$ are made the same as the diameters of two spur gears, which would give the desired speed ratio. At A and C perpendiculars to the two axes are drawn. Any line, as $F\,G$ drawn through B, and terminating on these perpendiculars, represents by $B\,F$ and $B\,G$ the diameters of two spiral gears whose spiral angles are $F\,B\,A$ and $G\,B\,C$ respectively, and which run together with the desired speed ratio. If we had taken F at F' and G at G' so that angle $F'\,B\,A$ was less than 45 degrees, then the diameters of the two spirals would be represented by $B\,F'$ and $B\,G'$, and the center distance of the two gears by one half $F'\,G'$. Another line $F''\,G''$ can be drawn of equal length, but making other angles with $A\,B$ and $B\,C$, showing that another pair of spiral gears can be made with the same center distance, but with other angles. If point F is brought down to A then $F\,G$ will be perpendicular to $B\,C$, and will never meet the perpendicular at C. In this case the second gear has become of infinite diameter, or a rack and the first has become a spur gear.

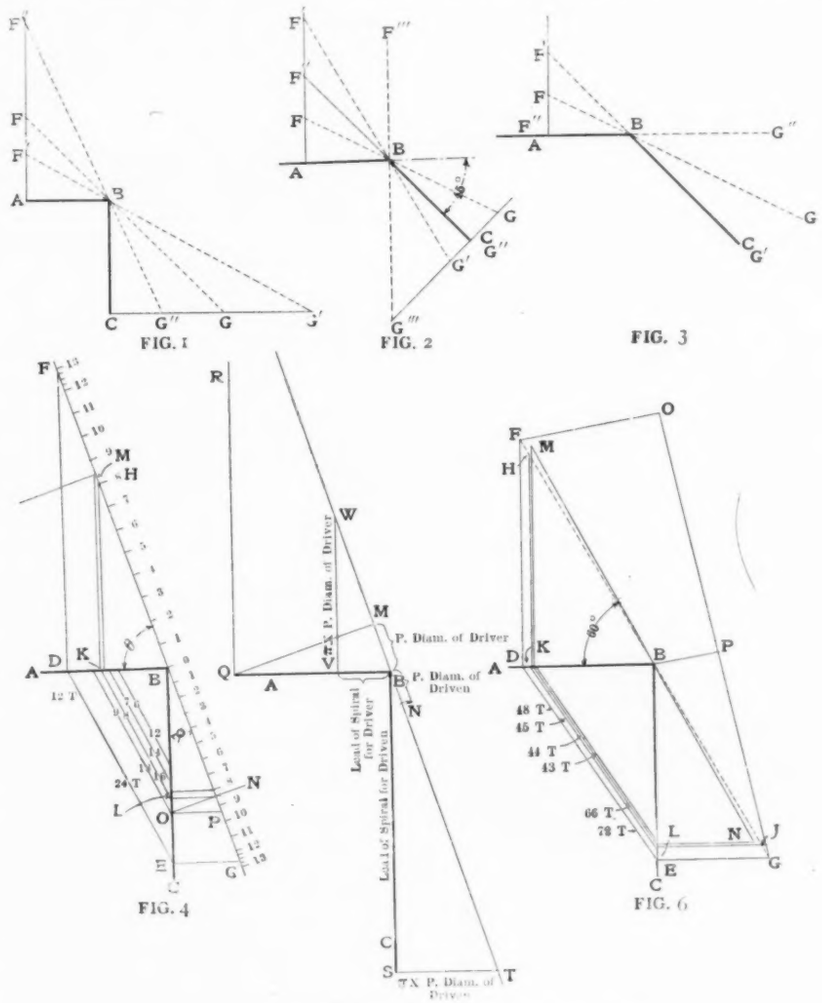
SPECIAL CASES

In Fig. 2 the gear axes $A\,B$ and $B\,C$ are taken at 45 degrees to each other. As before any line through B terminating on $A\,F$ and $C\,G$ will give us the pitch diameters and spiral angles of a possible pair of spiral gears whose speed ratio will be the same as that of spur gears of diameters $A\,B$ and $B\,C$. Their pitch diameters will be $F\,B$ and $B\,C$, their angles $F\,B\,A$ and $G\,B\,C$, and their center distance one half $F\,G$ as before. If F and G be moved to F' and G' we again have two gears with the same speed ratio, but with diameters $F'\,B$ and $B\,G'$, and the spiral angles $F'\,B\,A$ and $G'\,B\,C$, but of the same hand; that is, both right- or both left-hand instead of one being right- and the other left-hand. If $F\,G$ be moved to $F''\,G''$ so that $B\,G''$ coincides with $B\,C$, then the lower gear becomes a spur gear (0 spiral angle) and the upper gear has the same angle between the shafts and the diameter of $F''\,B$. If $F'''\,G'''$ be drawn perpendicular to $A\,B$, then its length will be infinite, its spiral angle 90 degrees, and it will correspond to a rack free to slide only along lengthwise of its teeth. To get a diagram showing the action of a spiral gear and ordinary rack see Fig. 3, where $A\,B$ represents the diameter and direction of the axis of a spur gear and $A\,C$, infinite in length, represents a line parallel to the teeth of a rack. If $F\,G$ is drawn, then $F\,B$ is the diameter of a spiral gear of spiral angle $F\,B\,A$, which will run with a rack whose teeth make an angle $G\,B\,C$ from those of an ordinary rack. If the lines $F'\,G'$ be taken, so that $B\,G'$ coincides with $B\,C$, then the rack becomes an ordinary rack, since angle $G\,B\,C$ has become zero. If $F''\,G''$ be taken, then the gear has become a spur gear and the rack has a spiral angle of $G''\,B\,C$.

Since these diagrams are applicable to problems stated as Mr. McCabe stated his, I give here a solution of each problem by this method.

PROBLEM I

In Fig. 4 lay off the two axes $A\,B$ and $B\,C$ at the shaft angle given, 90 degrees. From B toward A lay off any convenient distance as 1½ inches in this case to D, this line for the driving gear. From B toward C lay off a distance of 3 inches, in the same ratio to $B\,D$ as the speed ratio required. Draw $D\,F$ and $E\,G$ perpendicular to $A\,B$ and $B\,C$ respectively. Any line through B terminating on $D\,F$ and $E\,G$ will represent the diameters and angles of a possible pair of gears. In this case, which is the most difficult to propose, we have a ratio of diameters



GRAPHICAL CONSTRUCTIONS FOR SPIRAL GEARS

given of 3 to 2. Lay off on a piece of paper two scales, the divisions on one being 1½ times as large as those on the other and the two scales meeting at a zero point. Lay this point on B and turn the scale till the same number of divisions and fractions of a division lie on each side of B between it and DF and EG. This strip is shown in place. This line determines the angles of our two gears, and BF and BG will give us the diameters of two possible gears. But these gears are too large if we consider the diagram to be full size. Lay off $BH = 3$ inches and $BH' = 2$ inches and drop perpendiculars to AB and BC respectively. The distance from the foot of each perpendicular to B represents the corresponding spur gear and must be such that it will contain a whole number of teeth. To find if this is so lay off on AB distances from B which represent diameters of gears of the given pitch (8) one on each side of the foot of the perpendicular from H is usually enough. Connect D and E and draw parallel to DE through the points of division on AB. Where these cut BC will represent diameters of spur gears in the same ratio that we started with. In this case we see that our driving gear has between 7 and 8 teeth so we may make our two gears either 7 and 14 or 8 and 16 teeth. Since we cannot go below 3 and 2 inches respectively we will use the 8 and 16. Draw perpendiculars from K and L to AB and BC till they meet BF and BG at M and N. BM will be the pitch diameter of a driving gear whose spiral angle is θ and number of teeth 8, to mesh with a gear of pitch diameter BN with spiral angle ϕ and 16 teeth. To find the spur gear from which to select a cutter, draw NO perpendicular to BG and draw OP perpendicular to BC. BP will be the diameter of the spur gear, on the same scale that BC was laid off on, from which to select a cutter. The same construction at M is shown in Fig. 5 on a smaller scale. MQ is drawn perpendicular to BF, QR is perpendicular to AB. Where QR meets BF will give the diameter of spur gear from which to select a cutter. If as in this case this point comes off the paper, but it is evident that it will call for a gear of about 20 inches diameter or over 135 teeth, there is no need of completing the construction.

To get the lead of the helix, the graphical method is more bothersome than Mr. McCabe's but, for the sake of a check on the analytical work as well as a help to those who are not posted in trigonometry I will give it. In Fig. 5 extend BN until the distance from BC to BT measured perpendicular to BC is equal to 3 1/7 times the diameter of gear BN. Then SB is the lead for the spiral. The same construction for the upper gear making WV equal to 3 1/7 times BM gives us BV as the lead of the spiral. This throughout gives us the same results that Mr. McCabe found except for the typographical error in equation (4) at page 498 where d_2 should be 2.108 instead of 1.208.

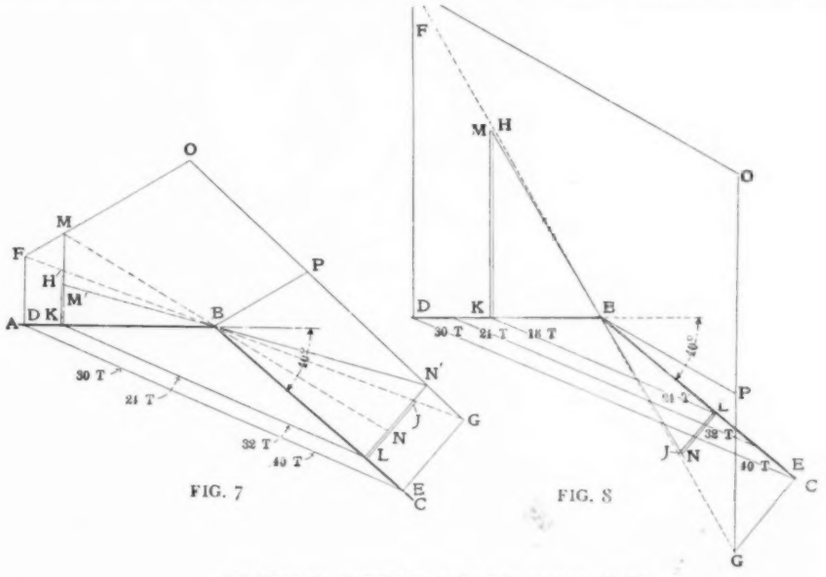


FIG. 7 FIG. 8

GRAPHICAL CONSTRUCTIONS FOR SPIRAL GEARS

PROBLEM 2

In Fig. 6 lay off AB and BC as before at 90 degrees. Lay off BD and BE in inverse ratio to the speeds required, and to any convenient scale. Erect perpendiculars to AB and BC at D and E, DF and EG respectively. Through B draw a line at 60 degrees to AB and cutting DF and EG at F and G respectively. The parts BF and BG represent possible gears having spiral angles of 60 and 30 degrees and having the required speed ratio but since FG is longer than 7 inches the center distance is too great, if we consider our diagram to be half size. To reduce to the required center distance draw OG at any convenient angle. Connect FO and draw BP parallel to FO. OP and PG are then in the required ratio. Lay off H and U distant from B the same as O and G from P. Drop perpendiculars to AB and BC respectively. From this point proceed to find the nearest whole number of teeth which can be used exactly as in the last problem. This will give us 44 and 66 teeth and will give us lines M and N perpendicular to AB and BC on which our line representing the pitch diameter must terminate. Since this line must be 7 inches long there will be two solutions, points M and N and corresponding to Mr. McCabe's solution being the only ones given since the problem requires θ to be near 60 degrees. The getting of the spiral lead and the spur gear from which to select the cutter are not given, since they are the same as in Problem 1.

PROBLEM 3. FIRST PART

Lay out AB and BC (Fig. 7), at 40 degrees to each other. From B lay off BD and BE in inverse ratio to the speeds required. Through B draw FG making equal angles with AB and BC about 20 degrees. FG is now double the center distance which gears of diameter BF and BG require, but it is greater than the problem calls for. To reduce FG to 6 inches proceed as in the last problem, drawing GO, OF and BP and laying off OP and PG each side of B at H and J. Then proceed as in the last problem to get the possible numbers of teeth in corresponding spur gears. These come very close at K and L to 24 and 32 teeth. Making the correction as before gives us the two possible solutions of MB and BN and $M'B$ and BN' for the pitch diameters with the angles of these lines to AB and BC as their spiral angles.

PROBLEM 3. SECOND PART

Fig. 8. Proceed exactly as in the last case, following the lettering of the diagram. Points N and J coming on the other side of BC show that the two spirals are of the same hand.

Worcester Polytechnic Institute.

The electrical transmission of energy at a very high potential has been carried on since the 1st of April, 1906, by the Grand Rapids-Muskegon Power Company, of Grand Rapids, Michigan, which has a 66,000-volt transmission line, aggregating 75 miles, from Rogers Dam on the Muskegon river, with branches to Grand Rapids and to Muskegon. At Rogers Dam three-phase current is generated by water-turbine driven generators. The company also has other plants under construction.

The current is stepped up from the generated e.m.f. of 6600 volts by transformers to the line potential of 66,000 volts—for some time past the latter has been actually 69,000—and is conveyed on No. 2 solid copper wire conductors, carried on wooden poles on a private right-of-way. Another transmission line on steel towers is planned, on which it is possible a potential of 100,000 volts may be employed.

Echoes from the Oil Country—Interpreting Language and Some "Corn-sheller" Troubles—Saving Labor in Business Correspondence

With our spelling, and our slang, and our idioms this language of ours is a curious and perplexing thing. I see that some of the engineering schools are emphasizing the importance of being able to put thought into clear and concise language. To run a shop successfully and on time, and without undue friction and wear and tear on the inner man, it is very necessary to be able to do a good job of interpreting.

It is a hard job trying to make out some of the writing that comes along, but it also is hard to get at the bottom of things after reading some of the epistles that have finely formed letters and nicely constructed sentences. A letter like this, while it may not be soothing, would seem to be plain; it would not seem to need an expert to get things right:

"Dear Sir—I am returning to you one of your cornshellers for repairs. This cornsheller has only been in use for three years, and has always been run by good men, and nothing but the best of corn shelled with it. It has never been right from the time we got it, but I thought that it would get better after it had been run awhile. It seems that we cannot adjust it so that it will run quiet. Sometimes after we have adjusted it carefully it will start off all right and then it will stop and we cannot turn it until we go all over it again. As others of these machines in this neighborhood have been running much longer than the time we have had this one, it is easy to see that it never was a perfect machine, and it would not be any more than right for you to send us a new cornsheller. We will not stand on our rights and insist on this, but will ask you to repair it at once without cost to us and return it promptly.

Yours truly,
Blank & Co."

Blank & Co. are very nice people. They are doing a good business. From information received they have working for them an "expert" cornsheller man. He must be an expert for he once worked for us, and it took him less than two weeks to graduate. He worked in other places around here and if rumor is anywhere near right he was equally rapid in getting through at the other places. Some people want us to send a man to show them how to shell corn, but Blank & Co., having such competent men working for them, did the work of that kind themselves. In view of the fact that it has taken them quite a time to find out that anything was wrong we will wait until we see it before we "go for" any of our men. Unfortunately for us we have men who are not all "experts," and some of them do make mistakes once in a while. We want to be right with our customers, but we want to be right with our men too.

HOW A MACHINE WAS ABUSED

Inclosed are two photographs taken from parts of the returned machine. The first of these, Fig. 1, shows a pin and the hole it once fitted in. Originally there

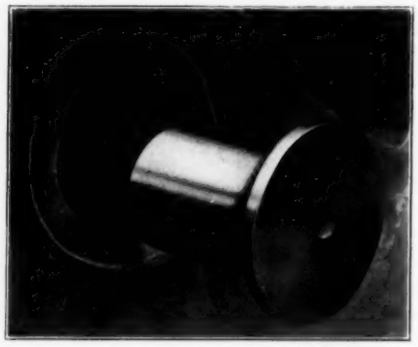


FIG. 1. SHOWING RESULT OF A PIN WORKING LOOSE IN ITS BEARING

was a collar on the pin. The one part was made to drive into a carefully reamed hole. It was kept there by a nut, and a large dowel pin was used to guard against a possibility of its turning around in the hole. The outer end of this pin formed a bearing for a rod. The bronze "brasses" in the end of the rod had evidently been keyed up so tightly that the dowel pin was sheared off and the working all done in the wrong place. The genius who did the keying was apparently so well satisfied that he had done a good job that he never looked at it again until he did so to

FIG. 2. A BADLY WORN LOOSE PULLEY

discover that the original construction had been faulty.

The other photograph, Fig. 2, shows the hub of a loose pulley. With this pulley the shaft runs and the pulley stands still when only one is running. It can be seen even by an untrained eye that the hole is not exactly round. The difference in size between the largest diameter of this hole and the original bore is seven-eighths of an inch. This slight difference did not attract the attention of the "expert" and the trouble caused by it was blamed on poor material in the place that broke.

It is touching to see the absolute confidence that a firm like Blank & Co. has in its "expert." They will uphold his statements in the face of the most adverse criticisms. The so called experts in the shop may differ with him, the testimony of the machinery may be adverse, disinterested parties may say unkind things about him, Blank & Co. may even yield to continued pressure and pay the bill for repairs—but through it all they will quote their "expert."

A shop man who can go to them and interpret this expert's real value to them in language that they cannot misunderstand has a good use of language.

It may sometimes unfortunately happen that through too much experience in interpreting letters like the foregoing a real trouble, for which the shop is responsible, is not given the attention it deserves. To prevent such things and do justice to all is where the fine work of the interpreter is shown.

TROUBLE IN GETTING MATERIAL

When you are running a shop and trying to be a little of everything at the same time, you may find that there is another place where you do not seem to be able to interpret meanings as accurately as you would like to. You order some material and are told that it shall be shipped "promptly." It does not come, and the reply to your inquiry, after the usual courteous statements of business conditions, tells you that "it shall receive our very best attention." After another effort on your part you again get the courteous statements, perhaps coupled with regrets possibly to the extent of a page or more, and are informed that "we are now in position to push your order through with the utmost despatch." If you have never been in this position, you might be astonished by the courteous versatility of the department that has such things in charge for some companies. It would be very entertaining if you could get rid of the haunting fear that the customer who is waiting for your work while you are waiting for the material may die of old age before you get his job done and the pay collected. Taking a hint from that up-to-date concern, the International Correspondence Schools, I have tried to benefit one such company, but I am beginning to fear that my efforts are not appreciated.

When a student sends in a sheet of drawings to be corrected, he is apt to discover upon its return that he has not reached perfection, for he will find numerous letters of the alphabet scattered over it in different places. Along with it he will receive a sheet headed "Key to Criticisms," and on it he will find the meaning of each letter, whether big or little. The idea is a good one. It does

not cover the sheet, as written or printed criticisms would. It does not take as much time to do, and when the sheet is received it can be understood more quickly and soon some of the most common mistakes are associated with their symbols, and the reference sheet does not have to be looked up for each one.

My idea is that the same idea can be put into use by the manufacturer of raw material; that is, raw as applied to the machine shop.

SIMPLIFYING CORRESPONDENCE

Think how nice and simple it would be. An expert would write a series of letters calculated to meet all the different combinations of excuses and explanations. These would be numbered from one up. I would suggest numbering them so as to be sure of distinguishing marks enough. The International people, who use the alphabet, found need of both capitals and small letters, and then had to use distinguishing marks to get the needed supply.

With these letters nicely paragraphed and the paragraphs properly numbered, the key to them could be greatly condensed. For instance, if you were referred to letter No. 742, you might find something like this: 1-1, 6-4, 14-7, 11-8, 1-5. Looking at instructions at the beginning of the book of letters, you would see that the number before the dash referred to the number of the letter and the one after it to the paragraph in that letter. From this you might readily find that 1-1 meant, "Your favor of recent date has been received;" 6-4, "We are very sorry indeed to learn that you have been put to inconvenience in this matter;" 14-7, "This is a size that by some reason we are out of at the present, and the machinery we use to get it out is undergoing repairs;" 11-8, "Owing to the unfortunate but unavoidable delay in your order we have directed the mill to use all diligence in finishing up this size, and have directed the shipping department to pay particular attention to it;" 1-5, "Thanking you for past favors, and hoping to receive your future commands, we beg leave to remain your most humble servants, etc."

Think of the immense saving that would result from this system. A copy of these letters being sent to each regular customer, whenever he sent in a letter asking leading questions, he would receive a card with a number stamped on it. That number, the date, and possibly the initials of the clerk who sent it would be all the work necessary. How easy it would be, too, to keep track of the information given to inquiries. Just the name of the customer and the numbers that had been sent. A guide for the use of the clerk would show that certain combinations must never be made. It would not do to send one letter saying that an order would be finished and shipped in three weeks, and then follow it by one that stated that the order had never been received. If the saving that should result from this was put into means for making excuses less needed, it would rejoice the customer; but if that was not done, it might swell the dividends or increase the salary list.

I at first thought of applying for a patent for this idea, but feared that it would not be allowed on account of the fact that it was somewhat similar to the practice of the International folks. I then outlined it to a representative of a company that I feel sure needs it badly. He was unfortunate enough to drop in when a bundle of letters from his firm, and which would do as samples to start the system, were under consideration.

I unfolded the plan to him very fully, and he promised to bring it to the attention of those in authority. As up to date I have not received either a block of their stock or a letter of thanks, I am afraid that it has been sidetracked in the interests of the stenographers and the manufacturers of typewriters. Some time in the future it may be forced into use, and when that day comes I want the credit to go to the shop where it belongs.

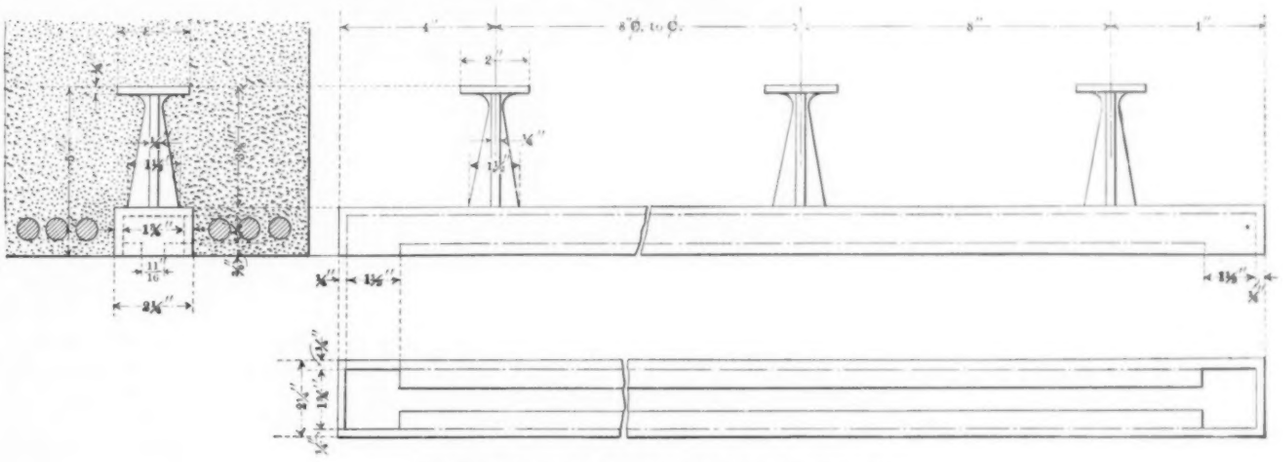
If any machinist wants to make use of the idea in accounting for his work, or for his behavior in the shop, he is welcome to do so.

W. OSBORNE.

The Attachment of Shaft Hangers to Concrete Buildings—A Troublesome Problem Satisfactorily Solved

EDITORIAL CORRESPONDENCE

One of the difficulties that besets the growing use of concrete for shop buildings is the attachment of shaft hangers to the building when finished. Provision for this must be made when the building is erected, as the satisfactory attachment of hangers to plain concrete surfaces is well nigh, if not quite, impossible. Among the plans that have been tried are the bedding of projecting-end bolts in the concrete, by which the hangers are secured directly to the beams, and another is the placing of pieces of gas pipe through and across the beams near their lower sides, through which horizontal bolts are passed, these bolts serving to secure light angle irons to the sides of the beams with their lower legs, to which the hangers are attached, flush with the lower side of the beam. The first method is obviously inflexible, the position and distance between the bolts being fixed in advance and allowing but little variation from a prescribed hanger plan. The second plan is much better, as the pipes may be used freely and the angle irons be put up where and when needed. This plan was used in the first portion of the new factory of the Burroughs Adding Machine Company, of Detroit, and while found fairly satisfactory, it has been superseded in the latest portion of the factory by the plan shown in the accompanying illustration.



ATTACHING SHAFT HANGERS TO CONCRETE BUILDINGS

The plan will be seen to comprise a T-slot-head casting, 30 or 36 inches long, and with anchors on its upper surface. The casting is placed in the bottom of the beam form, the tension rods and concrete mixture being then put around it. The T-slot has square openings at each end, through which the hanger-bolt heads are passed, the hangers being located at any point of the length of the casting. The

castings are inserted very freely in lines in both the beams and the slabs between them, the latter location serving for countershafts with or without light channels, or I-beams between the concrete surface and the hanger feet. In case bracket hangers are to be used for line shafts, the castings are placed in the faces of the columns.

The shop referred to is heated with hot-water ceiling pipes and these castings are also used to support the water pipes.

F. A. H.

The Engineer and Civilization*

By having been engaged in so many different kinds of work, I have no doubt been brought into contact with more kinds of workers than if I had been "to one thing constant;" and it has occurred to me that although I might be more or less barred from speaking of engineering, I might be all the more able to speak of the engineer. In what I have to say, therefore, I propose to take the man as my subject rather than his work, and to consider partly the engineer as seen by the world at large, and partly the world at large as seen by the engineer. By engineer, I need hardly say, I mean engineer in the widest sense, such as is covered by the all-embracing arms of the Institution of which, for a short time, you have made me the official head, and of which, for the moment, I am the spokesman, although always under that wise and familiar proviso that the Institution, as a whole, is not responsible for the individual opinions of its members.

ENGINEERS' ESTIMATE OF THEMSELVES

We have been told—and we are all very ready to believe good of ourselves—that the engineer is the most powerful instrument of civilization and progress which exists, because without him there would be no railways, no steamers, no telegraphs or telephones, no electric power to be distributed free to everybody, no motors, and hardly even the roads for motors to run on, with which latter, by the way, engineers have scarcely yet been able to furnish us. It all sounds very obvious, and we may each congratulate the other for his share in the stupendous engineering progress of the last half-century. It is always pleasant to feel ourselves very superior persons, and still more pleasant to be convinced that in earning our daily bread we have been also conferring high moral benefits on our fellow men.

I do not want to cool down the glow of satisfaction induced by the consideration of these views of existence, when enlarged upon by the more eloquent members of our profession. Possibly such ideas may even help some of us to do our work better, and, if so, they are of real benefit. But, if so, it can only be in the same fashion as that in which a foolish, or an unwise, or even a wholly misguided enthusiasm has sometimes led armies to victory; and it may be as well, as we are not at the moment in any danger of losing a battle by keeping cool, to take a more reasonable view of the relations between engineering and modern civilization.

THIS ESTIMATE QUESTIONED

The glorification of our profession, of which I have been speaking, while, as I have said, possibly useful to encourage us and keep us up to the mark, is, after all, surely due to reasoning in a circle. If we merely say that progress in engineering matters has been due to engineers, we say what is true, and what is at the same time practically the whole truth. But we have no right to assume that if there had been no railways and no telephones, no electric light and no motor omnibuses, the world would have been a whit less civilized, less moral, or less happy than it is. It would only have developed along other lines than the present mechanical ones. While engineers also are so ready to take credit for what they have done, they have to remember that they must also take their share of responsibility for it. Even without the imagination of the inventor of the "time machine," it is quite easy to conceive of a civilization developed on un-mechanical lines, under which our people might have been more thoughtful, better read (in everything except newspapers), less prone to absurd excitements about what we call "politics," less ready to join in united shouting about things they do not understand, less easily persuaded to bring the State even to the very brink of war with good friends and neighbors at the bidding of some "yellow" journalist, whose malicious ravings would never have had any circulation if we engineers had not provided the printing machinery and the special trains.

"PROGRESS" NOT NECESSARILY IMPROVEMENT

It is never safe to talk of "might-have-beens," but it is clear that it is mere begging of the question to assume that everything that has come about has been for the greatest good of humanity, that all the inevitable movement and change which goes on is toward improvement, or that the much misused word "progress" should always connote improvement at all. Do not many of us know in our hearts, at the end of a busy and worrying session—and all sessions appear to be busy and worrying—that we would contentedly sacrifice half our work, and more than half our incomes, if we could only live quietly and peaceably, have some breathing time to think and to see and to read, be a hundred miles from the nearest railway station, receive letters once a week, and know that telegrams cost a shilling a word?

This is by way of making it clear that I am not going to start on any discussion of the engineer with the assumption that he is the salt of the earth. But I do start from the position that, as his predecessors were responsible for starting the world on 100-lb. rails when it refused any longer to jog contentedly along on macadam, he himself must now do all he can to see that the lines laid and being laid are leading in the right directions, and not assume complacently that all roads lead to perfection simply because he has put them down. The world has chosen, for the present, that it will travel by steam or petrol. I daresay the choice is an unwise one. I confess I should like to spend the evening in setting before you a glimpse of a glorious world in which there would be as few engineers as there now are philosophers. That, however, would be obviously unsuitable for this particular occasion. The world intends to go by machinery for our time, at any rate, and we engineers are the drivers and the signalmen at the same time. I hope we may be able to do our work with a full sense of the serious responsibility of this double position.

THE ENGINEER, COMMERCE AND SOCIAL LIFE

We engineers, then, because of the nature of our work and its relation to the lines taken by modern development, stand in particularly close relationship to all the activities round us, to commerce and to social life. The subjects with which we have to do, and the ways in which they have to be dealt with, bring us into intimate contact with many branches of physical science, while our modes of thought and action inevitably affect art, interfere with nature, and even react on philosophy. Can we cultivate such an ideal that our widely extended influence shall really be for the benefit of the community, not only in giving them good railway service and cheap power, but in some wider and much more important fashion?

ENGINEERING A SCIENCE

In relation to science, I have always claimed for engineers a very high place, a place much higher than some of my purely scientific friends are disposed to allow them. M. Jourdain talked prose all his life without knowing it. So I really believe not a few engineers have spent their whole lives in scientific work while they were nominally only earning their daily bread in ordinary mechanical pursuits. It is not, however, so much that engineering is a science as that the scientific spirit is often the basis of engineering, and that when this is the case, engineering becomes as truly scientific as any other branch of exact research, and none the less scientific because it is also the means of making an honest living. Engineering problems differ from ordinary academically "scientific" problems, partly in that they are much more complex, and consequently more difficult of anything like exact solution, and still more because—exact or inexact—some solution to them has always got to be found. Not only must the solution be found, but it has to be translated into steel and gun-metal, as well as into

*Extracts from presidential address of Sir Alexander B. W. Kennedy before the British Institution of Civil Engineers.

£ s. d., and any mistake will entail very much more serious consequences than a controversial paper in the *Philosophical Magazine* or a letter in *Nature* pointing out a wrong estimate of terrestrial radio-activity in pre-historic epochs.

CHANGE OF WORK WITH ADVANCING YEARS

It has been, no doubt, a source of regret to many who have passed this chair, as it is to myself, that as years go on and experience accumulates, one's work comes always more and more to deal with men and matters, with general schemes and methods, even with financial means and possibilities, and less with the directly mechanical problems which fascinated us when we were younger, and for the sake of which, probably, we took to engineering at all in the first instance. This is one of the penalties of old age—of engineering old age, at all events; and it is no use lamenting it. But, speaking of the constructive part of an engineer's work and life, the part on which some of us look back as the very essence and joy of our careers, we can see that it consisted essentially of a long series of scientific problems to be dealt with, scientific questions to be answered. If the engineer has dealt with these by scientific methods, and in a scientific spirit, if he has carefully marshaled his data, deliberately reasoned from them, recognized where they were incomplete, estimated the probable effect of their incompleteness upon his judgment and upon the result, and, finally, made his decision and taken his action on the whole matter as a logical conclusion from his previous reasoning, then, I say, the engineer is acting as truly as a man of science as if he were conducting a laboratory research with appliances and methods of exactness and precision unknown in actual professional problems.

THE USE OF FORMULAS NOT SCIENTIFIC

But a word of caution—unnecessary to the experienced, but sometimes necessary nearer the start. The mere use of formulas or of exact calculations of any sort is not in itself scientific. That man shows far more of the scientific spirit who recognizes when his data do not allow of the use of any exact formulas, and who therefore reasons with what may be called mathematical common sense, than the man who tries to force the facts to fit a class-room formula, and arrives at a result which satisfies the formula without recognizing that it bears no relation to the facts. The scientific engineer may use elaborate calculations or he may not; a most important part of his science lies in judging whether to use them or not. Conversely, the man who calculates elaborately may be working scientifically or he may not. The mere calculation is not scientific, and in certain cases may only be a cloak to essential defects both in scientific method and in technical perception.

I am not going to discuss the question of engineering education tonight, still less the greater question of education in general. But the consideration of the relation of engineering to science gives me the opportunity of pointing out one matter which stands, or ought to stand, to our credit as engineers. In the discussion on the advantages of science as compared with classics as a means for early mental development, it is always pointed out that the former is based on rigid reasoning from phenomena which can be seen and weighed and measured, and I would certainly be the last to decry or to minimize this very real advantage. Perhaps, in the early stages of human or of mental development, it is desirable that the mind should be nurtured on dogma—fixed, certain, and infallible—and, if so, the scientific dogma is probably the least poisonous variety of the species. But whatever may be the case at first, most men who have devoted their lives to science have come eventually to hold their original dogmas very loosely, and to recognize that they are, after all, only semi-crystallized versions of very imperfect knowledge. And the engineer, of all men, should have the earliest opportunity of working himself free from the youthful leading-strings. From the day that his pupilage ends until the last day of his engineering life he is always face to face with the fact that there are half-a-dozen ways of doing everything, and that the half-dozen ways are more or less equally good. I suppose most of us carried our boyish cocksureness right through our pupilage, and left our first shops or offices with a notion that everything ought to be done exactly as it was done there. But the notion was dispelled with an almost overwhelming shock when we found out that elsewhere no one cared in the least what our people had been doing, but got the same results by quite different methods. The more we see of engineering work the better we know that none of our problems has one single solution, that all of them can be worked out to the same end in many different ways, and that it is very seldom indeed that, except as to some small detail, any one method is so much better than the others that it has any special claim to be called the right method. If this is the experience of our every-day life as engineers, and in relation to the things about which we know most and to which we have given a lifelong study, ought not we engineers to be able to set the world at large an example of tolerance and broad-mindedness in other matters and as citizens, which would not be easily reached by any other class of the community?

THE ENGINEER AND THE ARTIST

To what extent do engineer and artist come in contact? It can hardly be denied that there are points which at least ought to be points of contact in their work, although their paths seem frequently to intersect rather than to be tangential, and the intersection is too often at 90 degrees! When engineering structures were confined to masonry bridges and pumping stations the matter was comparatively simple. It was difficult to make a stone bridge which was structurally efficient and actually hideous at the same time, and many of the older structures of this type left nothing to be desired by way of beauty of line. Whether a castellated or a quasi-Gothic building was the most suitable form for a Cornish engine house may be questioned, but, at any rate, many of the pumping houses which once covered the country were not eyesores, and along with a not unpleasing exterior they combined complete internal suitability. It seems a little odd to us now—but it was certainly prompted by worthy motives—that even the machinery inside the houses was designed on architectural lines which were at least supposed to be lines of beauty. Even in the time of my own apprenticeship it was universal for bed plates, entablatures, and other large castings to be finished at their corners and angles with moldings more or less carefully designed according to classical models. Even moving parts, such as the bosses of cranks, were ogeed round their edges, and no connecting-rod of a stationary engine was considered finished without a double ogee ring round the middle of its length. Some of these details were survivals from cast-iron construction applied to a forgeable material, but they all died hard, like many less harmless customs.* Penn's oscillating engines in the Thames steamers, which were at work until only a few years ago, had their cylinder cover-nuts of gun metal, each made with a turned ogee molding at its base like a fixed washer; and the entablatures of the same engines were wonderful in their wealth of detail.

THE PROPER USE OF MATERIAL

We have long ago come to the conclusion that a mere copying of a classical outline in a wrong material is not artistic and is not beautiful. Not having had a metaphysical training, I do not feel competent to discuss the true inwardness of our consciousness that a Parthenon in cast iron, or Gothic tracery in steel bars and angles, however closely each might imitate its original, would not be beautiful. But whatever the reason may be, the consciousness is probably there with all of us. Possibly, if cast iron had been known in Athens 3000 years ago, our ideas would have been different. But as it was not, we must take things as they are, and recognize that our feelings of today, reasonable or unreasonable, are what really constitute the facts of the case.

As regards machinery of every kind, from marine engines to sewing machines, we have come to recognize that at present our business is to use the material in the

*I remember a pocketbook of the period which said of the connecting-rods of beam engines: "Makers of beam engines generally rely on this detail, as ladies do on their bonnets—namely, on the useful and ornamental conclusion of the paraphernalia of the whole, in which both parties delight to indulge."

place where it is wanted, and of the form best adapted for the work which it has to do. Between moving machinery and architectural structures there is no analogy; and to apply to the one the classical rules or conventions of the other, as was once attempted to a certain extent, is surely a mistake in art as well as in engineering, and the eye has now recognized this. But it would imply, I think, a very narrow range of perception of things beautiful to deny a beauty of a genuine kind—although neither classic nor romantic—to an express locomotive, or to a great marine engine as it stands in the erecting shop. We used to compare the hard outline of the steamship, with its clumsy funnel and abortive masts, with the graceful lines of the three-master and the beautiful forms and color of her sails. But even already, although steamships are things as yet of our own generation, now that they have cut themselves adrift from all suggestion of imitation of their predecessors, everyone recognizes that there is a dignity in a "Dreadnought" which is almost majestic; and that the modern liner, properly handled, forms really as fine a subject for a picture as a full-rigged ship, although naturally the pictures are different.

But with engineering structures the case is different, and certainly the question is more difficult. We have to build—or to get built for us—bridges, viaducts, dams, stations, power-houses, goods-sheds, factories, and so on. All of them come into direct comparison with the ordinary structures designed by the architect and seen and judged by the public at large. Often, unfortunately and unreasonably, they are compared, not with the ordinary structures, but with the noblest of architectural buildings, and we are asked to compare, say, York railway station with York minster, which is obviously unfair.

THE OPPORTUNITY IN MASONRY

Engineers nowadays have so little chance of building stone bridges that I can hardly mention them as modern engineering works, but the great masonry dams of such undertakings as Mr. Mansergh's Birmingham water works challenge comparison with any architectural structures. Unfortunately, few people see them, and the public generally are not disposed to judge us by Craig Goch or Caban Coch. Perhaps our greatest difficulty in this matter is with our steel bridges. They are unavoidably so much in evidence that even "the man in the street" considers himself fully competent to form, and therefore to express, an opinion about them. I need not say that "the man in the street" is really able to do nothing of the kind, except, of course, to express an opinion. None the less it behooves us to take care what we are doing, not for the sake of the mere surface opinion of today, but in order that, by the time our work has become ancient, it may also be considered worthy of the respect due to age, and not the mere survival of an early-Victorian period in the youth of engineering. Our first consideration should be—of course, after considerations as to strength and engineering suitability—that the form of the structure should be determined essentially by the material of which it is made, and not based upon the forms of older structures, however beautiful in themselves, built of quite different materials. The carved moldings and details which lend so much beauty to a structure of stone are apt to impress us only as "cheap and nasty" when reproduced in cast iron. Similarly, the curves and scrolls of a Gothic pattern, if imitated in malleable iron on a structural scale, do not give the idea of beauty, but merely of material used in a wrong way. The matter is not really one for argument; we must just accept the situation as it stands, and be thankful that we are not expected to be definitely ornamental as well as useful. Given, however, that our material, as a first law, is to be used in a fashion for which its physical qualities adapt it, it yet remains that there may often be half-a-dozen forms in which the material may be distributed, in which the economy will be practically equal, but of which the satisfaction to the sense of beauty will be very different. It would be impossible here, even if I had myself the necessary artistic knowledge, to discuss the question of how the lines of a structure—and our structures are all lines together—affect our sense of its proportions. But examples of structures which, although doubtless economically designed, are undoubtedly hideous, will occur to many. On the other hand, such structures as the Forth bridge here, or Roebling's suspension bridge in New York—many others might be named—are examples of what can be done to please the eye, while at the same time utilizing the material with every possible economy, and satisfying all the demands of scientific fitness.

LATTICE GIRDERS NOT NECESSARILY UGLY

At the risk, however, of being considered a Philistine, I feel bound to say that I do not consider a well designed lattice girder—such, for example, as those of the Charing Cross bridge—to be in itself ugly. I admit that the old Charing Cross station roof was an eyesore from the river, as is the present Cannon street station roof; but that is another story, and not at all an easy one to deal with, for *from inside* there appears nothing to be said against these structures esthetically. But as to the bridge itself, I make bold to say after another forty or fifty years, if the bridge is still in its place, it will be recognized that a straight line is not in itself hideous—which seems to have been recognized long ago in Athens. And if it be once admitted in principle that a girder bridge, in spite of being straight, may be looked at without pious horror, the critics may cease to affect displeasure, and even come to regard such structures as simple and straightforward, and in their whole effect not at all unpleasing. I speak, of course, of the girders themselves, and not of such cast-iron humps between them above the piers as there are at Cannon street, for which, I confess, I can suggest as little justification as I can for the shape of the sometimes admired arches of Westminister bridge.

LIFE LONG, ART SHORT

If it be suggested, as it sometimes is, that the "laws" of art are immutable, and that nothing in the universe can make a thing beautiful that is not already beautiful, I think we have a simple reply in the reversal of a popular proverb—in reality it is life which is long and art which is short. Life continues through all the centuries, but art changes its aspect with each of them. Is it to be supposed that the architects of Egypt or Assyria, whose buildings were sumptuous with frescoes and "graven images," would have appreciated the cold monotony of a Grecian temple of 3000 years later? Or would the architects of Athens have had anything to say to the men of the middle ages, who covered their temples with microscopic detail, who forsook the dignity of the straight line for the frivolity of the curve, and shut out the free air by bits of colored glass?

About engineering buildings the same class of questions does not arise. They must just take their place with any other buildings. If they are for purely industrial purposes, their form, and even their external appearance, must inevitably be mainly determined by their purpose. But even here we are most of us familiar with the extraordinary difference which a little artistic feeling can make by very small changes and at small expense, and I hope that in future we may not be so great sinners as in the past in this respect.

CO-OPERATION BETWEEN ENGINEERS AND ARCHITECTS

We expect architects to consult and employ engineers to help them over structural difficulties, and we may even scoff when they come to grief for not doing so. They are, on the other hand, quite entitled to turn the tables on us when they see that an engineer has put up a hideous barn which they could have transformed into a pleasing structure by their own special knowledge, and by that sense of form which it has been their chief business to cultivate, while we have been working at bending moments and breaking loads.

ENGINEERING AND NATURE

I have spoken of engineering in relation to art; it would, perhaps, be put down to cowardice if I did not say something of the relation of engineers and engineering to nature, especially as my mountaineering colleagues at the Alpine Club occasionally try to convince me that if I had any conscience I should renounce engineering altogether. We *are* sometimes guilty of dis-

figuring nature, I believe and regret. What is the extent of our guilt?

Our interference with nature—that is, especially with natural scenery—comes practically under two heads: the erection of works for the utilization of water, either for use in cities or for power, and the construction of railways in mountainous or other beautiful districts.

ENGINEERING WORKS NOT NECESSARILY EYESORES

The first is the easier to deal with. The conversion of upland valley bottoms into lakes by the construction of dams seems to me to be out of court at once. I am not inclined to admit that to cover boggy peat land with blue water is doing any harm to Nature, or that a fine masonry dam is an eyesore. Moreover, if it is required for the supply of water to cities which could not obtain the water otherwise, it is a "work of necessity and mercy," and there is no more to be said about it unless the engineer does his work with wanton disregard to all appearances, which, I believe, is never alleged. Water storage for power purposes can hardly be put upon quite so high a level, no doubt, and, unfortunately, such works are generally accompanied by pipe lines, which, it must be owned, are not things of beauty. But if the net result of the whole is to give employment to hundreds of men in places where hitherto no one could maintain himself, and to utilize natural sources of power, hitherto neglected, for doing useful work on the spot where they exist, then I think an impartial arbitrator would say that the schemes were justified, even at the expense of ruling a straight line on the landscape. I admit that *tu quoque* is not argument, but some of us who love the hills best find, I think, that the scar along the hillside made for a deer road is every bit as disfiguring in itself as a pipe line, while it is infinitely less agreeable in all its suggestions. It may cheer the guilty engineers a little to think that, if there is anything iniquitous in the utilization of water-power, then, *à fortiori*, our whole nation is involved in the guilt accompanying the utilization of its coal fields, compared to which the construction of a few dozen pipe lines is a quite microscopical offense.

I am not saying anything to justify the putting down of a village where hitherto there has been no more than a ruined hut, because this seems to me to require no justification whatever. If we engineers can help to create places where a few of the overflowing thousands of our population can find healthy and remunerative occupation, we have nothing to repent of, even if, as I quite admit, the bare landscape would please some of us (myself certainly included) much better than the sight of the works and cottages.

MOUNTAIN RAILWAYS

There remain to be considered mountain railways, or railways in mountainous districts. These really may be put into three categories. There come first the great lines, like the Simplon, which run through mountainous districts, and which are important means of continental communication. I have already suggested that it might possibly have been better for the world if it had stuck to stage coaches and had never gone traveling; but the world itself elected otherwise, and such works, therefore, require no justification. Also I must add that some of them—the St. Gothard and the Albula lines are examples—rather add interest to the landscape than disfigure it. I admit that in Switzerland I have often wished that the railways would burn smokeless coal, for in that case the trail of white steam would be a beauty in itself, and certainly more in keeping with the landscape than the trail of dust and filth which marked the course of the diligence along the high road.

For another class of mountain railways the same justification of public utility cannot be pleaded, while at the same time they are too often accompanied by appreciable injury to the landscape. I mean such lines as those from Grindelwald over the Scheidegg, from Visp to Zermatt and to the Gorner Grat, or, in our own country, up Snowdon, besides a host of miserable "funiculars." The whole class must be put together as merely the product of a modern tourist madness. They are absolutely unnecessary; they serve merely to get the public without trouble to places where the public would not otherwise go, and from which they never would be missed. But however much we may dislike them, and however strongly we may feel that no real benefit is gained, either by the public or anyone else, from carting trippers by the thousand up to the Wengern Alp, to look at the avalanches, it may be pointed out that we engineers are after all not responsible for their existence, but only for their safety after they have been decided on. The worst criminal requires the cleverest counsel, and we are entitled to suppose that the engineers who have taken up these works have considered that they acted for their clients in the same impartial spirit that a barrister acts for a defendant whom he knows to be a villain, but for whom it is his business to do the best he can.

I am afraid that this may be said to be all in the nature of special pleading, and confess that I would much prefer to be able to deny that engineers had anything to do with the matter at all. If an earthquake, with wisely selective tendencies, could wipe the whole of such lines out of existence, and leave the country as it was, the world would be all the more endurable, and the enemy would have no further cause for scoffing.

THE DAMAGE EXAGGERATED

I daresay that the feeling of contempt and dislike which we have for these things leads us sometimes, however, to exaggerate the actual damage which they do to nature. Happily, nature is very forgiving, and has a way of covering up engineering iniquities so completely, in a few years, that they practically disappear and cease to trouble the eye. It is not so, unfortunately, with the works of a kindred profession. The railway to St. Moritz, for example, is almost out of sight; the railway station is perfectly harmless; but St. Moritz itself, spread in all its hideousness about a lovely lake side, is nothing less than a scar on the face of the earth—an absolute shock when you catch sight of it suddenly. For this, happily, we engineers cannot be held responsible; I would gladly believe that Swiss builders employ no architects, if anyone would only say so authoritatively.

A HOPELESSLY BAD CASE

It cannot be denied, however, that there is a further class of mountain railways which represent criminality so bad that it ought to go without counsel altogether—railways which are not only totally unnecessary, but are violently and impertinently out of keeping with the spirit of their surroundings. Of such lines the so called "Jungfrau-Bahn" (which begins with a falsehood by implication in its very name) is surely the chief. The proposed line from Pontresina to St. Moritz by the Statzer See runs it very close, and the suggested lines up the Val d' Anniviers and the Schöllenen, and there are not a few others. I hope one can say that such lines are not initiated by engineers, but I wish one could also add that no engineer would have anything to do with them. I am glad to know that an influential Swiss society is at last taking up this matter with some vigor, both as regards railways and buildings, and we must all wish it success in its endeavors.

Thirteen miles of electric railway, forming part of the system planned by the company incorporated to construct a road from New York to Chicago, are to be built by the students of Purdue University, who will have full charge (under the guidance of the faculty) of the work of building the first section; the surveying has already begun. The *Electrical World* remarks, "This reminds one of the work done many years ago in England, when the students of one of the English universities, under the stimulus of John Ruskin's fervid eloquence, went in for a bout of road making, with pick, shovel and roller."

The tenth edition of "Graphite as a Lubricant" has been issued by the Joseph Dixon Crucible Company, Jersey City, N. J., and although issued primarily with the object of introducing the lubricants made by the company named, is nevertheless interesting and of value to all who are interested in the general subject of lubrication. We understand it is sent upon request to those interested.

PRECISION DYNAMOMETER SPRINGS

Methods of Doing a Remarkable Piece of Work

BY A. H. EMERY, JR.

In connection with the traction dynamometer designed for the Pennsylvania Railroad Company by A. H. Emery, of Stamford, Conn., and built under his direction at the Bridgeport works of the American & British Manufacturing Company, it became necessary to have some springs which would have an exact and uniform increment of motion for a given increment of load; the load on the springs being proportional to the amount of pushing or pulling on the drawbar, which could thus be measured by measuring the motion of the springs.

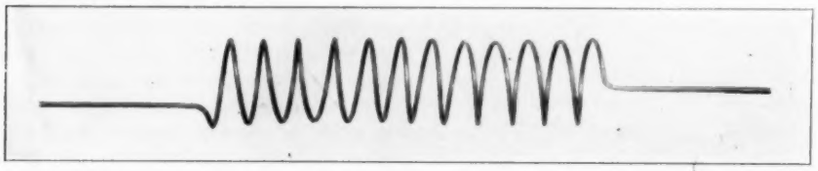


FIG. 1. COILED SPRING WITH END IN LINE WITH SIDE

THE USE OF THE SPRINGS

The design of the machine is such that about 1/36 of the load on the drawbar is transmitted to a piston, which carries on its piston rod a pen for making a line on a paper traveling at right-angles to the motion of the pen, and moving proportionally to the travel of the dynamometer car on the railroad track; the movement of the piston being resisted by the springs. The maximum ordinate of this record is 10 inches, and it is necessary that these springs shall move exactly 10 inches under a given load and that the rate of the springs shall be constant at all parts of their motion; that is, that a given change of load will give a fixed change of length at any part of the motion of the springs. It is also necessary that no permanent change of length occur in using these springs, and they are so designed that the strain on the outermost fiber, when fully loaded, is only about one-third of that usually allowed in springs. Also, the springs must be readily fastened and unfastened, as they are to be used in pairs, different pairs or combinations of pairs being used to give different values to the motion of the pen or the ordinate of the curve made by it.

AN EXPERIMENTAL COILED SPRING

For various reasons it was decided to use a compression spring of about 27 inches in length and 7 inches outside diameter, and the first design was to use a round wire coiled as in any helical compression spring, but with the ends turned so as to be in line with each other on the same side of the spring and parallel to the axis thereof as shown in Fig. 1. To prove that there would be no side buckling when such a spring was loaded with its ends held firmly in line and fastened so that they could not rotate, a sample spring was coiled, its two ends clamped firmly, and the spring compressed, and it was proved that no side buckling took place. After further study, however, this design of spring was discarded, for various reasons —the difficulties (1) of getting the two ends exactly in line after hardening; (2) of providing some easy method of fastening the ends to their supports, so they could have no backlash or rotation; and (3) of reducing the section of the wire after hardening to bring the spring to the exact rate desired.

SOME PRELIMINARY SPRINGS

About this time, the Pratt & Whitney Company sent out some small samples of work done on their thread milling machine, and a spring was designed, to be made by taking a spring-steel forging, boring and turning from it a hollow cylinder, placing it on a mandrel or arbor and then milling a spiral cut, starting near one end and stopping near the other, leaving a coil of nearly rectangular section. Such a spring was ordered from and made by Pratt & Whitney in their large sized thread milling machine. It is shown in Fig. 2.

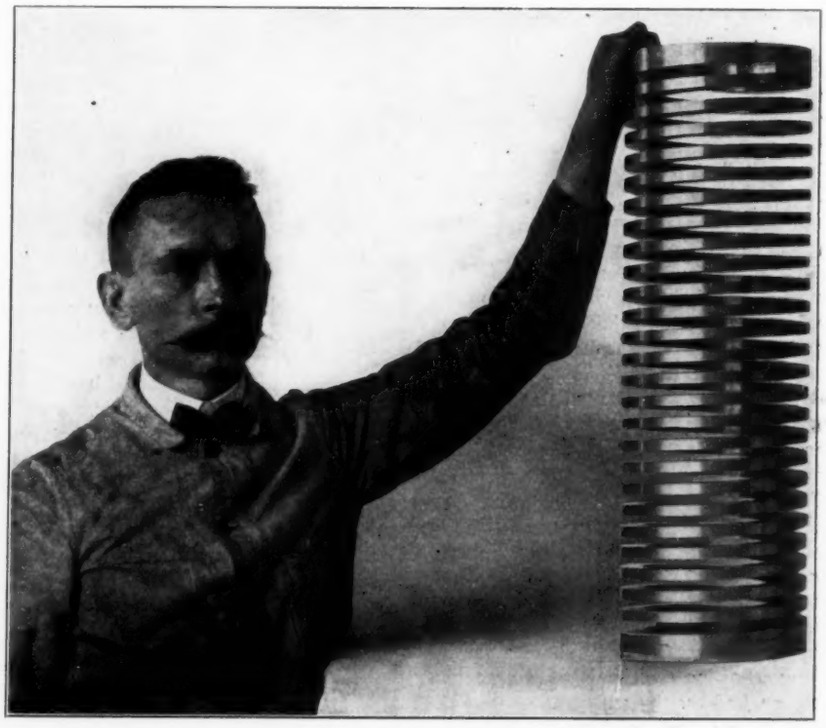


FIG. 2. PRELIMINARY SPRING MILLLED ON PRATT AND WHITNEY THREAD MILLER

The next step was the making of two short and two long springs of nickel steel, by boring and turning the blanks, placing them on mandrels and cutting the threads in a lathe instead of in the milling machine, the resulting springs being shown in Fig. 3. The two broken springs were hardened by heating and quenching in oil. The unbroken long spring was not hardened before the thread was cut.

THE FINAL METHODS

Tests of these springs, together with the one made by the Pratt & Whitney Company gave much information, and the set of eight springs shown in Figs. 4 and 5 was designed.

The two at the left hand of Fig. 4 were made first, and the manufacture of either was as follows (the only difference being that one is a right- and the other a left-hand coil): A hollow forging of 3½ per cent. nickel was bored and turned, leaving the thickness of the wall slightly greater than the calculated thickness of the coil when finished, this allowing for loss by scaling in hardening, and making the spring slightly too stiff, so that it could be carefully reduced until it had exactly the desired rate. This machined cylinder was then placed on an arbor, the ends finished to make the length of the blank 20½ inches, and a thread of ⅞ inch

pitch, ¼ wide, 21 turns, was laid out on the surface of the cylinder, the thread stopping at equal distances from the ends of the cylinder. Holes tapering in widths from the width of the thread to about ⅛ inch (see Fig. 4) were laid out for the lathe tool to start and stop in; and holes for pins screwing through the cylinder into the arbor, to act as drivers, were also laid out, and then drilled through the cylinder and spotted on the arbor. The cylinder was then removed from the arbor and the starting and run-out holes drilled, chipped and finish-filed, and the tapped holes in the ends for fastening the spring in place in the dynamometer were laid out, drilled and tapped. The blank was then replaced on the arbor, the driving-pins put in, and the thread cut clear through to the mandrel, and the cylinder thus made into a spring. The blank fitted the mandrel tightly, so that we were able to cut into the mandrel slightly and smooth the inner corner of the coil.

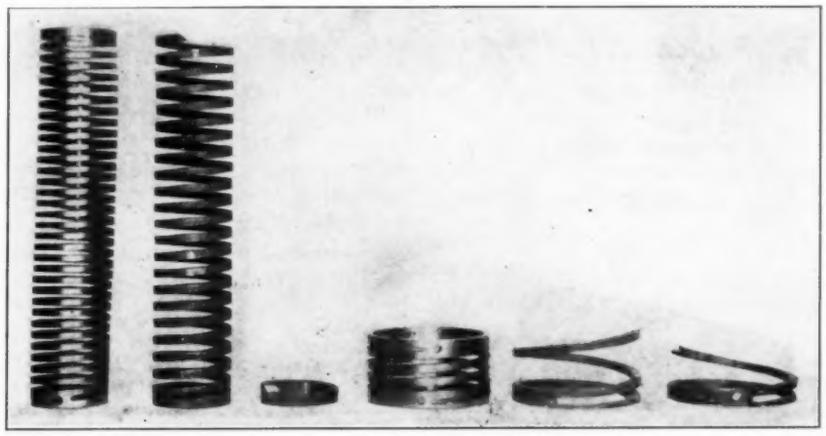


FIG. 3. PRELIMINARY SPRINGS MADE IN THE LATHE

This spring was then placed in the testing machine, loaded in tension, and stretched till its normal length, lying on its side, was changed from 20½ inches to 27¼ inches, and it was then ready to harden. The testing machine used for this stretching was a vertical machine, which added to the difficulty of doing it accurately, for the load on the upper coil was greater than the load on the bottom coil, by the weight of the coils, or about 50 pounds, and, consequently, the upper coil would take a permanent stretch before the middle or lower ones, so that the spring had to be turned end for end several times during the stretching, and the middle coils had to be additionally loaded by hand.

METHOD OF HARDENING

The spring was then mounted for hardening by placing it over a piece of wrought-iron pipe, 1 inch smaller in diameter than the inside diameter of the spring, and slipping three ½-inch rods between the spring and the pipe, to hold the spring central, and then every fourth coil was fastened by screws on either side, screwing into the pipe, there being three lines of these screws. A handling apparatus was designed and built, so that the spring and pipe could be held in an oil furnace, rotated and moved around, so as to get evenly heated; and when at the proper temperature they were brought out and plunged into a tank of oil. The first apparatus did not work rapidly enough, however, and twice the oil in the tank (4 feet in diameter and 6 feet deep) took fire; and, worse yet, when the spring was examined, it was found to be slightly out of round and the coils very irregular in their spacing. After some testing to determine the rate of the spring, and to see if it had had hardening enough, it was again placed on the pipe, and this time every coil was fastened by three pairs of screws, so that the spring was fastened at about 63 places; also, a change was made in the handling apparatus so that the spring was gotten into the oil very quickly and was dropped in vertically—still on the pipe, of course.

SCRAPING AND GRINDING

After this second hardening the springs were tested carefully and found to be too stiff, as was intended, and were then worked down by scraping the outside and inside and between the coils with a hand scraper, measuring the diameter of the spring before and after scraping; but when re-tested, it was found that the motion for a certain change of load had not increased as much as was expected; however, after doing this several times, the scraping got down to a metal that the scraper would not touch, and further tests showed that the hardening had produced a surface metal to the depth of about a hundredth of an inch, which had very little effect upon the action of the spring. An expanding arbor was then made and the spring further reduced by grinding in an ordinary grinding machine, the spring being frequently tested until the rate was very nearly that desired. This method was very tedious, as the springs had gone considerably out of round in hardening, making them difficult to mount upon the arbor, and it was decided to harden the hollow cylinders before cutting them in

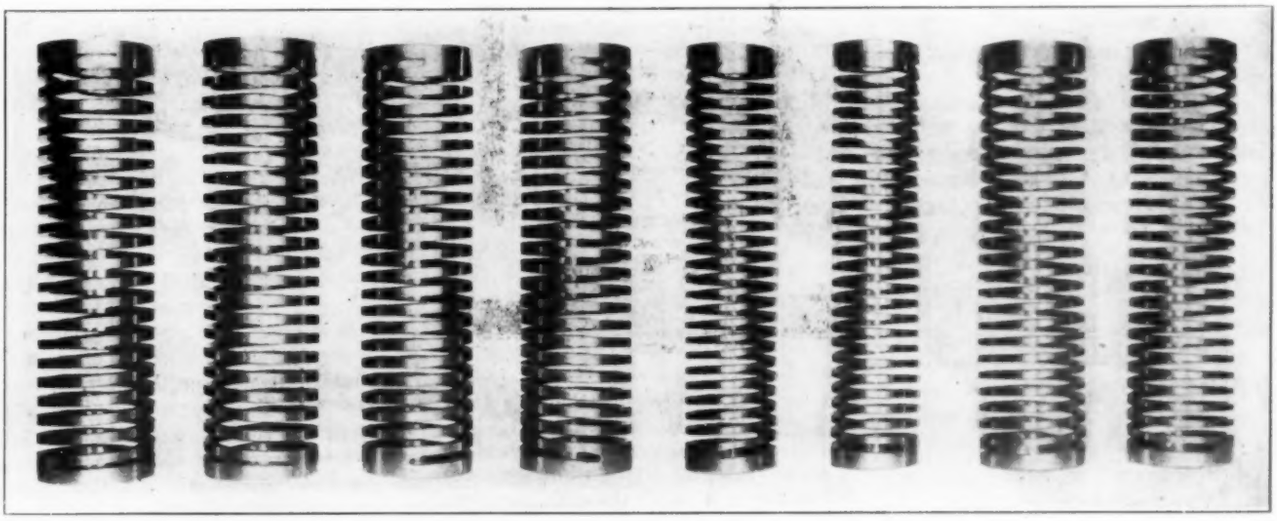


FIG. 4 FIG. 5

FINAL SET OF EIGHT SPRINGS

the lathe, and the rest of the springs were made in that manner; that is, by rough boring and turning the nickel-steel forging, finishing the holes in the ends for fastening it into the dynamometer, drilling a starting hole for the lathe tool, oil-hardening the cylinder, finish-boring and finish-turning it, then laying out upon its surface the spiral to be cut, drilling the run-out hole for the lathe tool, placing it on a mandrel, and then cutting out the spiral or thread, leaving the section of coil desired.

SOME OF THE DIFFICULTIES

The cut was made by roughing it out about 1/32 inch narrower than the final width, down to within 1/32 inch, or less, of the bottom; then finishing the cut on the sides and working it to the desired width, using size-blocks. With a sharp-pointed tool, the sides were carried down until the tool cut through to the mandrel, thus removing the last of the metal, in the form of a strip of ribbon. This cutting was very difficult and tedious, as the lathe had to be run at its slowest speed, with back gears in, and with a pulley on the line shaft only one-half the size of the regular one. Only one kind of tool steel was found which would stand up at all, and that required grinding almost every other cut, and frequent dressing and special hardening. If the tool could be gotten to cut dry, it did the fastest work, but, on several of the springs, turpentine had to be used constantly. This method of finishing the cut left a thin fin, or rough edge on the inner corner of the coil, and the spring was then placed in the testing machine and stretched as far as it could be, with safety, when this corner was smoothed up with a file and emery cloth.

RESULTS OF TESTS AND FINAL DIMENSIONS

The tests of these springs proved (1) that their rate for the amount of motion which they would have in use was constant; (2) that there was no change in rate when passing from tension to compression; and (3) that there was no discoverable difference between the curves of loading and unloading.

Spring.	Outside Diameter.	Inside Diameter.	Coils.	b	h	Weight.
4A	7.3	5.9	20	0.7	0.57	58.6
4B	7.3	5.9	20	0.695	0.579	58.0
4C	7.1	5.7	21	0.7	0.57	58.4
4D	7.05	5.7	21	0.673	0.588	57.5
1A	6.88	5.9	22	0.475	0.425	31.6
1B	6.88	5.9	22	0.482	0.422	32.0
2A	5.6	4.55	24	0.525	0.41	28.9
2B	5.6	4.55	24	0.525	0.41	29.4

DIMENSIONS OF SPRINGS

The dimensions of the springs are shown in the accompanying table.

In other words the springs moved an equal distance for a given change of load throughout their range whether the change of load was by addition or by subtraction.

THE FORMULAS USED

The springs were calculated from the following formulas:

$$P = \frac{2S}{3D}\sqrt{\frac{b^2 h^2}{b^2 + h^2}}$$

$$F = \frac{2 PD^2 l}{4G}\,\frac{b^2 + h^2}{b^3 \quad h^3}$$

P = load.
S = fiber stress.
D = pitch diameter spring.
l = length of one coil.
h and b = length and breadth of section of coil.
G = about 9,500,000.

This value of G was calculated for springs whose section is rectangular, with only a small difference between the lengths and breadths of the section of the coil, and subsequent tests with nickel steel show that it is higher than this, for round bars used in helical springs.

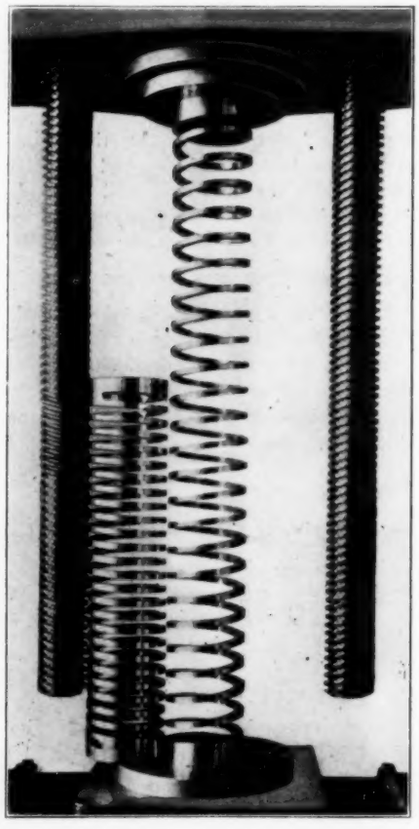


FIG. 6. A SPRING UNDER TENSION IN THE TESTING MACHINE

FINAL TESTS

After the springs were worked down to give as near the motion desired as the limit of accuracy of the testing-machine. they were placed in the dynamometer, and a hydraulic load put upon the pistons, and their motion measured for calculated loads per square inch, and after being carefully rated in this manner, were further reduced until they had exactly the desired motion; their probable error being about a thousandth of an inch in the ten inches.

In order to test the springs in this way by hydraulic pressure, it was necessary to be able to measure that pressure with extreme accuracy; and in order to do this, a special hydraulic pressure-measuring machine was designed and built, which will be described and illustrated in some future number.

These six springs (like the first two) were at first considerably too heavy; but as they were bored after hardening, they could be placed upon an arbor and ground down any desired amount.

TEDIOUS NATURE OF THE WORK

Some idea of the difficulty and expense of making these eight springs may be gained from the following statements: It was over a year from the time the Pratt & Whitney Company started on the first experimental spring till the set was finally completed, and the work was carried on almost constantly. The cylinders, after hardening, were extremely difficult to bore and turn, and in one we had the misfortune to get some molten cast iron, melted from a cap on the end of the handling pipe, and this, of course, chilled so hard that no lathe tool or even cold chisel would touch it, so that a special grinding rig had to be fixed up on a lathe, and the inside of this blank finished by grinding.

Although care was taken to have the furnace at the same temperature in all cases, some of the blanks were much harder than others. It took nearly two days of hard work to drill a hole 7/16 inch in diameter and 5/8 inch deep in one of them, while in another, where we got the drill to start cutting dry, and did not allow it to stop feeding and have a chance to glaze, we were able to drill the hole in 15 minutes. The drilling was finally accomplished in the hard cylinder by first grinding the drill to a sharp point, drilling a little, and then grinding it to a blunt point, using turpentine, slow speed and heavy pressure; the drill being of high-speed steel, specially hardened. One thread was cut in seven working days, while another required about 27 days of steady, hard work. It took, on the average, two days to file off the fin or rough corner, and the work was ruinous to files.

Each testing of the spring took a day or more of expert work; and then, after it was reduced by grinding, it had to be re-tested and ground again repeatedly, until the pair had the desired rate; and after they were as near correct as could be determined by the testing machine, it took about 20 days of the most expert work to test them in the dynanometer itself and find out their error, correct it, and finally calibrate the spring.

NDEPENDENCE OF THOUGHT AND ACTION

Why Manufacturers of Machine Tools Are Cautious About Getting Out Radica Designs—Machine Builders and Their Product Sometimes Ahead of the Times—Technical Schools and Instructors

BY INSTRUCTOR

Of all the forces which make civilization differ from savagery and which make civilization progress public opinion is the strongest. Upon reading Entropy's communication at page 484 one might at first be led to think that he would like to set this force at naught, but further reading may set one to thinking is some such vein as this: If we stop to think of it how few things there are, little or great, which we habitually do week in and week out which are not influenced by our fear of what people will think or our desire of approval from those same people. How often we are martyrs and suffer real pain and often great inconvenience for fear that we will be thought queer if we do otherwise. More people are kept out of jail because they know that they will lose caste in their particular social sphere than for fear of the punishment itself. This is as it should be. More vote a straight ticket in either party because someone else does than really know what either party stands for or what the candidates are, which is *not* as it should be.

THE MANUFACTURER AND THE CUSTOMER

The same thing follows with absolute certainty in engineering and manufacturing. More designers of machinery follow what someone else has found will sell well than sit down and reason out their designs themselves. Manufacturers are all the time doing what they consider consulting engineering work for their customers, for nothing. But is it real engineering advice that they give? Not often. Usually it is advice which the manufacturer thinks will please the purchaser. When he knows that a bitter pill will do his customer good he does not dare to give it, even sugar coated, for fear of what his customer may think.

CONSERVATISM OF USERS OF TOOLS

There are two ways of fastening the compound rest of a lathe to the cross slide which are about equally used. I formerly built a lathe in which one method was used and had no trouble in selling it. One of my neighbors in the business was in the shop looking around. He saw this feature and asked me if we could sell the lathes easily with that style of fastening. I told him that we could not sell any other kind. "Well," he said, "I wanted to use that style and tried to but our customers sent them back." Another case: I got up a turret lock and binder all operated by one lever so that the operator could unlock, unbind, and swing the turret and lock and bind it again all with two motions of one hand. We sent one out to a customer who had one of our old-style machines. He positively refused to see any good in it even after I had demonstrated before his eyes that in spite of his fears to the contrary it would lock positively in the same place every time.

NEW DESIGNS EXPENSIVE

And so I could go on indefinitely, citing cases where improvement has been balked at every step by the desire to turn out machinery which would suit old customers. It costs money to change designs no matter how much you may improve them, because of users' opinions. A new shop can make better headway putting some new machine on the market than an old concern just because they have no line of old and critical customers to whose opinions they feel obliged to defer.

"NEW" MACHINES AND OLD

Of course "new" machines are being brought out all the time. But all that is new is that the bearings are "greatly enlarged" and "more metal is being put in." Twelve or thirteen years ago I designed a line of engine lathes which are still on the market for those who want them, and I find it very interesting to watch the "new" lathes as they come out and see how they agree or disagree with this line. Lately a 38-inch lathe was brought out, especially designed for use with high-speed steel with a front bearing only an eighth of an inch larger than this old design.

A PREDICTION UNFULFILLED

I believe that in these columns about 25 years ago someone predicted that inside of 20 years lathe spindles would be made as large as one-quarter the swing of the lathe. Here is an eighth of an inch in say 12 years, or one inch in a century and still there are two inches or more to go. Two hundred years is nearer the mark. Why does not someone make a break and jump right up to this mark all at once? For two reasons—both due to fear. The builders are afraid that their dealers' and customers' opinions will not back them up and the designers are afraid to do anything but safe designing. Events have proved this good sense. Time and again shops have been prosperous, have built up a good trade, have redesigned their machinery the way they thought it ought to be, thinking that they had gotten the confidence of the public only to find that the public would not follow them and that they must halt.

A MODERN LATHE BUILT YEARS AGO

Whether this was the case with a certain lathe which I have in mind I do not know. I only know that the design was far ahead of the times when it was made and that the concern which made it has already sunk so far into oblivion that I can find no trace of it, though I have made diligent inquiry. Looking the lathe over there seem to be points all the way through that have been copied (or re-invented) in other much more modern lathes. The feed gearing alone has been copied by two concerns both of which built machinery which was ahead of the times a few years ago. The whole design is clean cut and symmetrical. It might be sold today for an up-to-date lathe if it were not known that no such firm as the one whose name plate appears on it has been in existence for years.

EDUCATORS AND ENGINEERS

I run up against technical schools repeatedly. They are just as sensitive to criticism as any designer, but whose criticism is it? Not the criticism of the men who hire their output, but that of men who run other educational institutions. It is natural. There is no place of which I know where technical professors and business men or engineers commonly meet on the same plane. They make cliques by themselves with almost no interchange of ideas. Once in a while you find a man in one of these schools who knows what engineering requirements are but it is the exception rather than the rule when you find him so situated that he can influence the policy of the school with which he is connected. That is, the real opinion to which the schools defer is the opinion of educators, not the opinion of engineers.

THE IMPORTANCE OF THE PRACTICAL MAN

I have watched the work of numerous men in these schools and I think that even educators themselves must agree with me in saying that the man of practical training is making himself indispensable to the student progress. The danger is that finding himself surrounded by professional educators he begins to feel that their opinion is the one which should influence him, and adopting the line of least resistance, he is apt to allow some of his work to deteriorate from an engineering point of view for the sake of the good opinion of what to me seems the wrong set of people. And so I think that Entropy strikes the keynote to the situation. Do not stop being influenced by the opinion of others, but pick and choose the ones to whose opinions you will lend your ear and let the rest go. INSTRUCTOR.

Each cylinder of the new Bourdreaux-Verdet duplex internal-combustion engine is equivalent to two ordinary cylinders, as the piston has an annular portion at its lower edge. Thus a two-crank engine is the equivalent of an ordinary four-crank machine.

CORRESPONDENCE

Discussing Phases of Machine Design and Construction

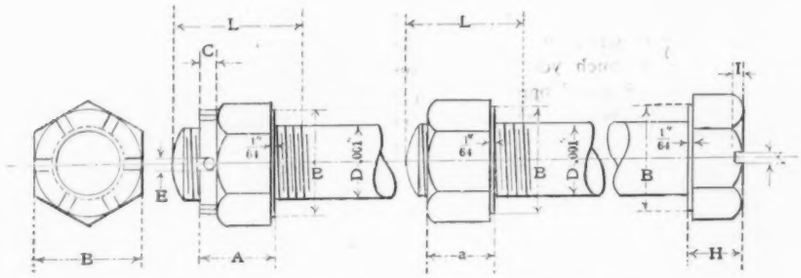
Standard Screws and Nuts for Automobiles

The blue-print herewith shows the standard for screws, nuts, etc., adopted by the "Association of Licensed Automobile Manufacturers." An additional column at the bottom of the sheet gives the length of thread as worked out by the formula above. This may be of benefit to those who are interested in automobile work.

GERALD.

A Defect in Patent Office Practice

One of the things that is undoubtedly not clear to many inventors is the fact that in applying for a patent no light is thrown on the question whether the invention infringes other patents.



D	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	11/16"	3/4"	7/8"	1"
P	28	24	24	20	20	18	18	16	16	14	14
A	9/32	21/64	13/32	29/64	9/16	39/64	23/32	49/64	13/16	29/32	1
a	7/32	17/64	21/64	3/8	7/16	31/64	35/64	19/32	21/32	49/64	7/8
B	3/8	1/2	9/16	11/16	3/4	7/8	15/16	1	1 1/8	1 1/4	1 7/16
C	3/32	3/32	1/8	1/8	3/16	3/16	1/4	1/4	1/4	1/4	1/4
E	5/64	5/64	1/8	1/8	1/8	5/32	5/32	5/32	5/32	5/32	5/32
H	3/16	15/64	9/32	21/64	3/8	27/64	15/32	33/64	9/16	21/32	3/4
I	3/32	7/64	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8
K	1/16	1/16	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32
d	1/16	1/16	3/32	3/32	3/32	1/8	1/8	1/8	1/8	1/8	1/8
L	3/8	15/32	9/16	21/32	3/4	27/32	15/16	1 1/32	1 1/8	1 5/16	1 1/2

TABLE SHOWING AUTOMOBILE SCREW AND NUT STANDARDS ADOPTED BY THE A. L. A. M.

In dealing with an application in the Patent Office extensive searches are made and it is decided whether or not the invention is new, references are cited which interfere with the claims of the application, but no attempt is made to state whether the application is an infringement of any patent in force. Although the patents cited by the Office would perhaps be infringed if the claims of the application were allowed yet they are not cited because they are infringed, but because they show or describe the same invention. Provided the invention is found to be new, or is altered to avoid the references cited and conforms in all respects with the rules of the Office, then it is considered patentable and a patent is issued.

The average patentee assumes that because he has a patent, duly bedecked with a large seal and ribbon, nothing on earth can keep him from making, using and selling the invention. This is not always the case, however, for it is perfectly possible that the invention cannot be used without infringing some patent in force.

Let us suppose a simple case. A has a patent which claims "A box having a cover." B discovers that it is of great convenience to have the cover hinged to the box. He applies for a patent and claims "A box having a hinged cover." The Patent Office finds that no one previous to B has used hinged covers on boxes. They, therefore decide the invention to be patentable and issue a patent to B. Now B although he has something new and patentable cannot use it without the permission of A, for he cannot make "a box having a hinged cover" without making "a box having a cover," and that right belongs only to A. If he cannot come to some agreement with A then he must wait until the expiration of A's patent before he can use his own invention. It can be seen that B's invention is not shown or described in A's patent so that in the Patent Office proceedings A's patent would not be cited as a reference against B.

This is but another reason why an inventor should first become acquainted with the prior patents relating to his invention before putting money into an application for a patent. Often a patentee uses an invention on which he has a patent for years and then is called upon to pay heavy damages for having infringed some other patent all that time. The amount of money needed to buy the copies of the patents which related to his invention would have been extremely small compared with the bill for damages which he may have to pay.

IRVING D. KIMBALL.

The "Wise Expert" Lines an Engine Up—A Mean Trick is Played on Him

Dixie's article on the "steamtrap," at page 487 brings to mind an incident that once came within my own experience, on which occasion I first participated at a surgical operation—the reduction of a swelled head. In this case it was not the genus "vigilant upper officer" who was the subject, but another variety of the genus homo—"the wise expert." I had always supposed myself pretty familiar with the species, but compared to this specimen the others were paste of a poor quality not to be mentioned in the same breath. His line was marine gasolene engines, and what he did not know about them would more than fill the "Encyclopedia Britannica." He could expound by the hour on lubrication; compression; the merits of the jump spark vs. the make-and-break; the solid vs. the reversible wheel; the four vs. the two cycle, etc., etc. And what he said was cast-iron incontronvertible truth in the original package direct from the fountain head of knowledge. When he got through you actually felt round-shouldered from the weight of profound fact that had been unloaded upon you. You might have opinions of your own, but they were brushed aside as so much valueless chaff. In fact you did well if you managed to squeeze an opinion in edgewise while he was taking in a new supply of wind. Ordinarily even this was snatched from your mouth, half baked, you might say, and its component parts ruthlessly torn limb from limb and strewn about the floor to expose the fallacy of your views.

I had a splendid opportunity to cultivate the society of W. E. At that time I was employed with a concern building gasolene launches. We built the hulls only, installing any engine the customer chose.

I attended to the engine part of the business. W. E. had charge of a branch agency in the same town for a prominent firm of engine builders. We used a number of his motors, and he would drop in at the shop frequently in the way of business. The installation of a motor in a launch hull is not an operation calling for an unusual expenditure of gray matter, the main requirements being the placing of the outside bearing or stuffing-box so as to bring the shaft central with the hole in the skag or keel, the alinement of the engine shaft with the wheel shaft and the careful wiring of the electrical outfit. We did the alining by making the engine bed a trifle low and then raising the engine to the proper hight by means of thin metal liners or shims. The coupling was removed, and we tested the alinement with a straight edge placed against the shaft. W. E. never interfered with the work except to offer copious floods of comment and advice. But when one day we got an order for a thirty-six footer, to be equipped with one of his twenty-horse, four-cylinder engines he announced that he would take charge of the installing himself. This evidently was a job of too great responsibility to be intrusted to ordinary dubs. Said he, "I'll line that motor up so that it will not be off more than the thickness of the finest tissue paper."

"What's the difference," exclaimed Bill—who helped me with the motors—in disgust, after W. E. had taken his departure, "between putting in a ten horse or a twenty?"

"Never mind," answered Ed, one of the shop owners, "if he wants to put in his time free gratis and take the responsibility of the job we're going to let him."

So when the hull was ready we uncrated the engine and boosted it over into the boat and onto its bed.

It was not long before W. E. blew—that term fittingly describes his mode of entrance—into the shop and took charge of the job. Under one arm he carried a good sized package which he deposited upon the top of a tool chest. Throwing off his hat, coat and vest, he undid his parcel, the contents of which proved to be a pair of new bib overalls, one of those wooden blocks containing a set of scales from one inch up, a combination square, bevel, center gage and level and several cold chisels. Bill looked at me and I looked at Bill. It was evident that there were tricks in the installing game beyond us. However I noticed that the tools remained upon the top of the chest throughout the job.

"Now then," announced W. E., as he carefully adjusted the port suspender of his overalls to the thousandth part of an inch, "the first thing is to get the outside bearing on the stern post and the inside one on the end of the shaft log."

This explicit and detailed order given we were left to our own devices while he entered into a highly technical dissertation upon the causes of backfiring, for the enlightenment of a bunch of boat cranks who made the shop their hangout. In the course of an hour or so we got the bearings on, and incidentally discovered that the shaft was something like a foot too long. At the expense of much elbow grease and with the aid of an 8-inch hacksaw the 3-inch shaft was cut off, also the keyway for the flange coupling. Slipping the flange on the end of the shaft after cutting the new keyseat I found that instead of a close fit, there was enough play between the parts so that the flange could be wabbled slightly on the shaft. This meant that when the key was driven in, the face of the flange would be anything but square with the shaft, a state of affairs with which we were pretty familiar. W. E. heard me through, smiling tolerantly as I explained the fault.

"Never you mind about that," said he, dismissing me with a peremptory wave of the hand; "there is absolutely no part of our motors allowed to leave our works unless it is perfect in every respect. Our system of gaging and inspection insures perfect workmanship in every detail. Our"—but here I took refuge within the boat.

Well, that settled it, and I drove in the key. We were now ready for the lining-up and, W. E. tore himself away from his audience and clambered into the boat. His method of alining the two shafts was to place a flange on each shaft and then move the engine until a space or crack equal in width to the thickness of a sheet of note paper existed between the flanges. By means of bars Bill and I moved the engine until the paper was nipped equally all around the flanges. The lining up process was a very painstaking affair, and toward its completion the amount of movement required of the engine became so minute that several times we merely rattled our bars against the engine base, never attempting to move it at all, but it all went.

The alinement finished, we were ordered to "bolt her down," and W. E. hove himself overboard and resumed his discourse.

As soon as W. E. had gotten out of the way I reached down and gave the shaft a half turn. The crack between the flanges at once closed up on one side and gaped open twice its former width on the other. I showed it to Bill. Bill got down and examined the coupling critically, turning the shaft back and forth, watching the crack open and close, first on one side and then on the other. When he straightened up, his angelic countenance bore a well matured grin, and as he looked at me the shutter of his right optic closed once. The grin gave way to an expression of childlike innocence as he projected his head over the side of the boat and addressed W. E. who, with folded arms and bulging chest, was under full stream.

"Say, mister, before we go ahead with this you had better take another look at it, it don't seem to be just right yet."

For a full minute W. E. eyed Bill. Could be believe his senses, was he actually doubted?

"Right," he exclaimed, "of course it's right. What do you suppose I was doing in there?"

However, Bill persisted, and W. E. again got into the boat. He took one look at the coupling and then indicating the engine with a jerk of his head enunciated, "She's slipped." (Imagine an 1800-pound engine, of its own free will squirming round on a bed that sloped only 10 degrees.)

However, slipped it was, and again the lining-up process was gone through. As soon as W. E. again betook himself off Bill got down and gave the shaft a yank in the other direction.

"Say, mister, she don't seem to be quite right even yet, guess she's slipped again."

W. E. turned to his audienc with a look that plainly said:

"Well, what is the matter with those fellows now?" However, he didn't say anything, that is, not aloud. He knew that that engine could slip, so it was again lined up. But there was going to be no slipping this time. While W. E. guarded that crack as a cat would a rat hole Bill and I were ordered to get in a couple of lag screws. The last screw in, W. E. straightened up with a sigh of relief. "First case of that kind I ever had," he explained to the others as he climbed out of the boat; "must be due to the vibration caused by the pounding on the other side of the shop, etc., etc."

Bill waits until W. E. is well under way again and then gives the shaft another turn. But he does not at once call attention to the state of the alinement. Instead he sits down and waits until his physiognomy again resumes its natural appearance. I hide mine behind the engine. "Say, mister," Bill again squawked out when he regained control of things, "this foundation must be settlin,' she's bad 's ever."

W. E. does not say anything, he is plainly worried, and mad too. I believe that if he hadn't seen the engine bolted down while he stood guard over that crack he would have accused us of moving it. The other were interested too by now, and as W. E. examined the coupling there was a row of heads lining the gunwale. They even offered advice and made suggestions, and two or three even had the temerity to climb over into the cockpit and examine things for themselves. It was then, when W. E. and several more were bending over the shaft, that Bill did the mean thing. Grabbing the shaft, he turned it slowly back and forth several times, then he suddenly doubled up and hung limply over the cockpit coaming. I heard the other fellows get up and several of them sacrilegious enough to snicker outright. I could not see W. E., for I was industriously counting the shingles upon a neighboring shed roof. He did not resume his discourse, seemed to have lost interest in things. Shedding his overalls he again wrapped up his square, scales and chisels, and, after a short wait so as to seem not too precipitate, took his departure. He called at the shop several times afterward, while I was there, but his stays were brief, and the inner mechanism of the fountain of knowledge seemed to be "out of whack" to quote Bill, for she failed to fount. G .W.

Turning Millstones

Some years ago when I was just out of my time, working in a little jobbing shop several miles from nowhere, the foreman came to me and said, "Say, Billie, how would you like to try your hand at turning up those millstones over there at the face-plate"—this being the name applied to a headstock, with a six-foot face-plate screwed on to the spindle, and a movable tool rest which was bolted to the floor in any desired position. I had seen one of the men working away at a stone all morning, and I naturally suspected that there was something wrong, so I asked him, and he told me that Fred couldn't get a straight cut off to save his life (job), and that all he wanted me to do was to try, no fault to be found if I failed. The first thing I found was that Fred had his tools almost as hard as fire and water could make them, and these tools wore away about as fast as the stone came off. Remembering that I had often trued up grindstones with a piece of ordinary iron pipe, I drew a couple of tools to a dark blue, and found that they worked much better. Still, however, they wore away far too much for anything like a straight surface, so I shaped them somewhat like a pencil point, found how much they wore each revolution, then started a cut and put a chalk mark at one place on the stone. Every time this came around—which was about once a minute as the stones were 5 feet in diameter—I fed in about 1/64 inch. This brought a sufficiently straight surface, and I was con gratulating myself on being so successful when the thought struck me—"How many stones are there?" It already had become tiresome watching that chalk mark. All machinists who read this will doubtless imagine my feelings when I found there was a canal boat load of them waiting not far off. However, I stuck it out, when I rolled (not alone) the last one down the plank from the lathe(?) I vowed it was the last, and when the foreman told me a month later that another load had arrived, and to get things ready, I quickly discovered that there were many reasons why I needed to go elsewhere.

The stones were for hulling mills, i.e., one remained stationary and the other revolved just far enough away from it to rub the husks of the grain off.

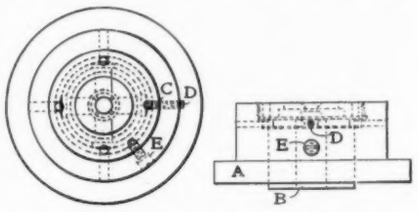
W. L. Mc. L.

An Extractor for a Shell-drawing Die

The illustration shows a die bed for shell drawing fitted with extractors which will close up close to the punch and no farther. Some extractors in use, such as the hinged one, if adjusted too close are apt to score the punch if it should be softer than the extractor. On very thin shells this style works to perfection, as it must close close on to the punch and has no tendency to slip back.

The bed *A* is of cast iron cored to take the core *B* which in this case projects a little beyond the bed. The pieces are recessed to keep the bed central by a projecting boss. The core is machined to take the four extractors which are a little less than the depth of the gaps so as to insure a sliding fit. The top of the core is turned down so as to act as a stop for the lugs on the extractors and prevents them from closing too far. They are closed by four spiral springs *C*, of which only one is shown. There are four screws *D* for adjusting the tension of the springs if necessary.

The extractors are rounded on the top



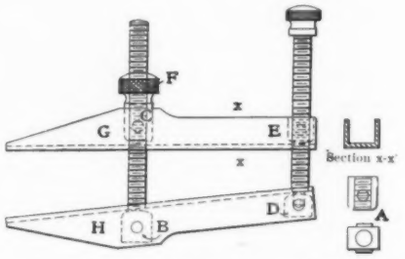
AN EXTRACTOR FOR A SHELL-DRAWING DIE

so that they are readily opened when the shell is forced through them. They are finished smooth so as not to mark the shell. The die bed is bored out to allow the extractors to open. The top of the die bed is bored and threaded for the clamping ring which holds the die in position, and also allows the die to be taken out readily when necessary. The ring is tightened with a spanner wrench for which four holes are provided. The set screw *E* is to hold the core in position so as to keep the extractor in line with the springs. C. Petitjean.

London.

A Light, Strong Toolmakers' Clamp

The jaws *G H* of this clamp are made of 1/16-inch sheet steel bent to a U shape as shown in the section *X X*. Two 3/16-inch holes are drilled on the sides to fit the pieces shown at *A*. These are made a little different in shape from one another. The screw *B* swivels. It goes through *C* which also swivels. It has a nut *F* to tighten the jaw. On the other



A LIGHT, STRONG TOOLMAKERS' CLAMP

end of the jaw is fitted the swivel piece *D* for the screw to abut against. On the other jaw is the swivel *E*, which is threaded. To assemble the clamp care must be taken to bend the sides out carefully with a tapered wedge, only enough so that the swivels can drop in, then close the sides together in a vise and the clamp is completed. It will be found that this style of clamp holds work well.

R. A. Almond.

Factors of Ignorance—Necessity for Commercial Judgment in Proportioning Parts such as Gearing, Belting, Cutting Tools, when not fully Informed as to Conditions of Use

In machine design there is a factor which enters into all computations for the strength of materials, a "factor of ignorance," ignorance of the conditions under which the machine will be worked. A tool may be constructed to take a certain cut at a given speed. It is highly improbable, however, that it will be taking this cut continuously or even often. Must the machine be so designed as to take this cut easily, with a liberal factor of safety? or can allowance be made for the fact that it is likely to be an exceptional occurrence and view it as an overload? This will govern the price to a great extent. To take an actual example: Many of the formulas used for the strength of gearing have a factor in them to limit the load so that the wear of the teeth shall not be excessive; the allowable load given by these formulas is well below the breaking point. Is it commercial good practice to use these formulas in the case stated above?

The allowable effective tension on leather belting is another case which may be cited. The maximum effective tension which may be gotten from double belting under ordinary conditions is somewhere about 60 lb. per inch width. F. W. Taylor (*Transactions* A. S. M. E., Vol. XV) has shown that the most economical effective tension having regard to repair and upkeep lies in the neighborhood of 35 lb. per inch width. A German investigator, Gehrchkins, recommends even a lower tension than this, a tension which varies with the diameter of the pulley and the speed of the belt.

If the belt will be worked to its maximum but seldom, the effect on the life of the belt need not be considered, but the designer who installs a belt to work continuously at 60 lb. per inch width is clearly at fault, possibly causing the users of the machine to suffer losses through stoppage of the machine and operator.

The proper selection of formulas too is an important matter. Different formulas may be used for varying parts in which the factor of safety varies. This makes some part of the structure too strong. That is, gears may be powerful enough to transmit twice the power a belt is capable of giving to them or in a similar way shafts may be made much stronger than gears on them. It is right being on the safe side, but if one part of a machine is out of proportion with another it is money wasted and if the driving member is made the stronger it is inviting trouble.

McANIC.

Punching Work in a Shuttle Die

In the description of a "shuttle die" for punching chain links, at page 545, by Mr. Weinland, it seems from the description that the "shuttle" or sliding plate *D* has been made too thin. Why not make it 9/16 inch thick, and chamfer both the upper and lower corners 1/32 inch, or a little more? This would allow for a little variation in the thickness of the work, and also permit a little variation in setting the press and grinding the punches.

RIGGS.

A Gage for Taper Holes

A very successful gage for determining any variation in size and depth of a taper hole in a piece where a line on a gage cannot readily be seen, is made as in Fig. 1 with a tool-steel bar *A* over which screws sleeve *B*, and at a given diameter in the work (as at *C*, Fig. 2) a corresponding diameter is determined on the gage at *C*, the contact of the gage with the work being at surface *D*, Fig. 2. The gage parts are threaded 40 per inch, and the sleeve is graduated to read in thousandths.

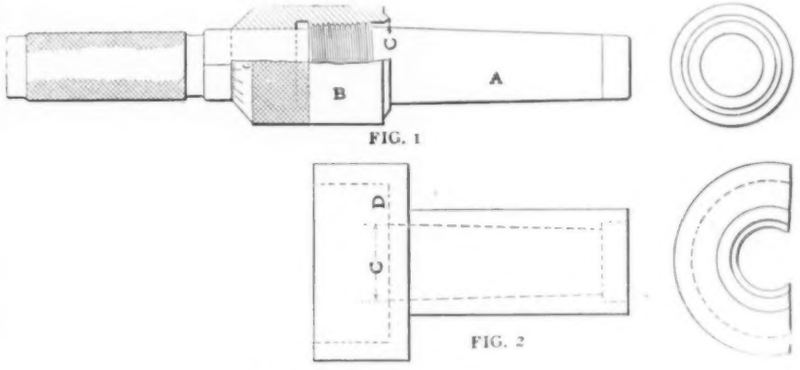


FIG. 1

FIG. 2

A GAGE FOR TAPER HOLES

GERALD.

Cannot Symbols Used in Formulas be Standardized?

Recognizing that I am venturing beyond my depth into a field entirely foreign to my education and training, I will apologize before I go very far. As it is a matter relating to books, and to some of the practices of what I conceive to be the authorities, I may be taking a very wrong view of the matter. If so, I am going to try to make someone else take at least part of the blame, and I have selected the AMERICAN MACHINIST as being the most culpable. You see, it is this way. I don't always agree with everything I read in it, but the reading keeps me thinking, and because of the thinking, I arrive at certain conclusions. If the conclusions are the results of thinking caused by the reading, and the reading would not have been possible except for the AMERICAN MACHINIST, men have often had worse excuses for doing things than I have for crediting it with being responsible for part of my mental attitude.

As applied to the mechanical world, we all agree that standards are the thing, and the only thing. Whether it is screw threads, hose couplings, gages, or the little pieces that the machinist turns up and hides for future use, as Chordal tells about, the cry is standardization until we have a learned society giving such subjects the most careful consideration. If a man wants to be "jumped on," let him interfere with or depart from our carefully worked-out standard shop methods. Gradually I have grown to be a crank on these matters along with the rest, and it is this that may be getting me into trouble by leading me to dip into matters too deep for me.

I will own up to another failing. I am lazy. I dislike to admit it, but it is true. I always want to get results in the easiest way. I want to blame part of that also on the AMERICAN MACHINIST, for it has taught me how to make a given exertion get the largest results, and if it had not been for that, I would not be so much in favor of standards, and gages, and simplified spelling, and such.

In arriving at standards, it is natural that the important things are given attention first, and it sometimes happens that something gets to be very important that has not been given attention, and when the interested ones get to it they cannot agree on a standard because each one fancies that his way is the best. Perhaps also efforts may be being put forth that are not known to the general public, just as some gentleman occasionally offers for our enlightenment something that was old to the trades 30 years ago.

Following the advice of the AMERICAN MACHINIST freely offered on occasions too numerous to mention, that all should study and seek to improve, has brought me face to face with what seems to be a deplorable condition. The strength of material is of the first importance, and naturally a machinist who begins studying does not go far until he gets mixed up with it, and mix is a good word to use. Just now my complaint is about the use

of the symbols. I will give a few samples. For area of cross-section of a beam or column, I find *A, S, F, q,* and *a* used. For moment of inertia, *I* and *J*. For radius of gyration, *R, G, r* and *p*. For section modulus, *R, S, Q* and *Z*. For distance to outermost fiber, *c, n, x, a, v, X* and *y*. For stress in extreme fiber, *s, S, R, f, p,* and *P*. Not only do different books use different letters to represent the same thing, but often it is done in the same book, and then each of the letters is also used to represent something else on the same subject. Generally some sort of an explanation will be given, so: "*A* represents *x*," "*S* represents *y*," etc. Sometimes this is omitted I can imagine getting an arithmetic, for instance, and before some problems see it stated: "In these problems × stands for division, — for multiplication," etc., and a little further along get the cheerful information that, "now, if — stands for addition, and × for subtraction," etc., "then ****," and have that kept up throughout the work. I can also imagine people tapping their foreheads when speaking of the author and the publisher, and in the machine shop hearing remarks that sounded like "he's got wheels;" "there is a screw loose in his machinery;" "bats in his attic" and similar suggestions.

I have given only a few of the cases of the confusing use of symbols, but the books are full of them. To a man who knows all about a subject, these things may not be of any moment; but on the surface it looks to a greasy shop mechanic as though the books were about a century behind the shops in regard to getting out work. Computation is work, and it takes time; and time has to be paid for. Formulas that are generally recognized by engineers in their work may be said to be standard; and why not have a standard form of expressing them?

We have men of mighty minds who are reaching out down into the shops, and pointing out our shortcomings, and we are much the better for their help; and now they would do us a further favor if they would do a good, thorough job of standardizing in their own realm. I know that some people will "kick." In the shops some fellows kicked about high-speed steels, and shop orders, and heavy lathes, and snap gages, and blue-prints, and a lot of other things that have come to help in the march of progress. More and more the rank and file want to "know things," and if the wise men cannot agree among themselves on a proper system for the statement of higher information, they may some day wake up to the fact that there has grown up a "shop system" for such statements, and while they may be able to point out how absurd, and illogical, and unphilosophical it is, it may be altogether a different thing to eradicate it.

This may be very much more difficult than appears at first glance. *S*, as standing for the pull a piece will break under, seems all right as standing for stress, while it may be all wrong. *R* begins rupture, and would be appropriate, because the piece breaks; but then *Z* is a good letter to use because it is the end of the alphabet, and when a piece breaks that is apt to be the end of the piece. To make it not appear as though the English were trying to run the earth, a Greek, Latin or Chinese character might be considered the thing. Let one thing be always known by one and the same symbol. Get down (or up) to uniformity, so that an extract from a text book, if printed in the AMERICAN MACHINIST, does not have to be like the drawing that Chordal tells of the young draftsman making. In the place where he was working a drawing was supposed to be able to explain itself, but his drawing had to have several sheets of foolscap along to carry the necessary explanations.

I live hoping that at some time in the future the advertisements which come to me of the latest publications will start out something like this: "All of the formulas in this volume are stated in the abbreviations adopted by the Society for Standardization. A list of them will be found both immediately before and after the index, and the index will be found both at the beginning and at the end of the book. From now on we will refuse to publish any book in which the formulas are not reduced to standard form."

W. OSBORNE.

A Machinists' Tool Chest—A Reminiscence and a Reflection

This chest is designated so as to overcome the usual disadvantages found in chests. The dimensions given make it convenient to carry by the handle on top; this is not shown in the drawing.

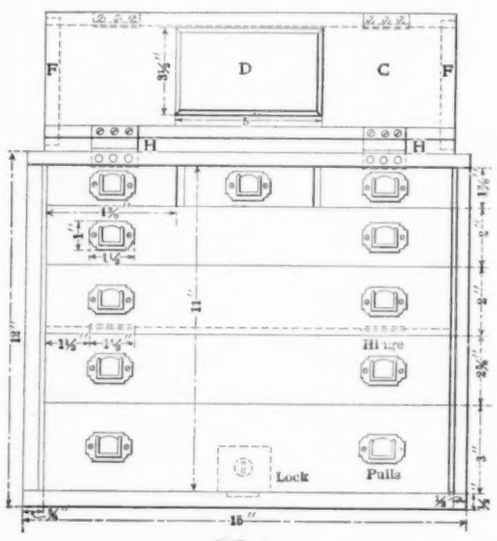


FIG. 1

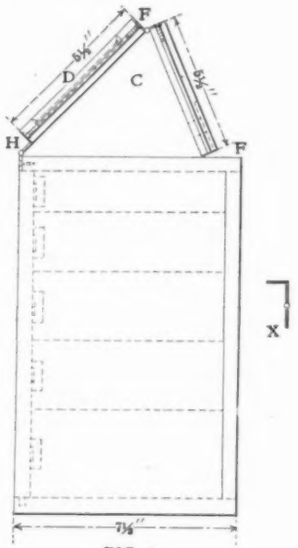


FIG. 2

A MACHINIST'S CHEST

Fig. 1 represents the front of the chest, with the front open. The cover *c* is made in two parts, which fold over on hinges. Fig. 2 shows the position in which the cover rests when the chest is open. In Fig. 1 the cover is shown in dotted lines, as it would appear when locked, the cover setting in flush with the front. A small mirror *D* is set in front of the cover. This is a handy attachment to any tool chest, as one can put his collar and tie on without chasing down to the end of the shop for one. At *F F* strips of steel or wood are inserted so as to prevent the covers from warping. The style of hinge used at *H H* is shown at *X*. Further explanation is, I think, unnecessary, as the drawing and dimensions make the rest plain.

A WATCH CASE AS A MIRROR

Mentioning the desirability of having a small mirror nearby recalls an amusing scene I once witnessed. In one shop that I worked in there was a toolmaker who had the advantage of a few years' study in a well known technical college. He was dubbed "the Count" because of his fastidious ways and styles of dress. There was another character called "Frenchy," who was fond of practical jokes, many of which he worked on the Count. One day he got up an argument with several of the men as to the difference in the grade of a number of bronze castings, the only difference being that some of them were tarnished. Frenchy had the men examining the pieces through a magnifying glass of the ordinary type, with a black rubber frame. This glass was doctored by rubbing prussian blue around the inside of the rim, which was hard to detect. The Count was working at a lathe nearby and, as though to settle the argument, Frenchy called him over for his opinion. Now, if anything pleased the Count it was to ask his opinion on any subject on which he could display his superior education. So he hastened over, screwed the glass over his eye, examined them carefully and declared there was no difference. When he took the glass from his eye he was at a loss to understand the cause of the roar

of laughter that he was greeted with. The fastidious Count did look comical with the blue circle around his eye. After searching around that section of the shop for a glass he gave it up, and then displayed his practical knowledge by taking out his watch, opening the back, and gazing at his decorated optic. It struck him as being so funny that he had to join in the laugh. After that he was more wary in taking part in anything that Frenchy was connected with. PEDRO.

Using Text-books and Hand-books—Cast Iron and Its Uncertain Qualities—A Useful Material Nevertheless—A Thorough, Rock-bottom Education better than a Patchy One Built on Sand

When, at page 523, Mr. Osborne says: "Knowing . . . . that text- and hand-books are for the use of those already educated in the subject," etc. it suggests that possibly my rejoinder at page 282 gave him this item. I do not happen to have this article at hand, but if I grouped text-books and hand-books together like this I humbly apologize. A text-book should never be used by anyone except a student who is studying under the professor who wrote the book. No one else can read them anyway. This is something in line with the old idea that every manufacturer should build his machinery in such a way, by the use of odd threads, etc., that no one else could repair it. It is pretty hard luck for the man who does not happen to have the opportunity of studying under some learned professor, but it is part of the trade of being a professor. To be sure, the correspondence schools have knocked some pretty big holes in the professor business, but so far their books have been mostly written by some of the lesser lights, and they are apt to leave out some of the steps in their logic as well as to make some other slips. But then it seems better to me to have some books that one can read, and which are occasionally illogical, rather than books which shoot so far over the heads of the masses that we are given to wonder if the authors thought they knew what they were talking about themselves. The best text-book there is in a general way is the last eight or ten years of the AMERICAN MACHINIST. When anything has been through a discussion in these columns, the upshot is likely to be about right, and it is written in a way that most people can understand. If you want any one item in a hurry, you can quite likely find it quicker in a hand-book; but if you are going to use either a hand-book or a text-book to get anything out of with which you are not already partially familiar, I am sorry for you.

THE PRODUCT OF THE CUPOLA AND OF A GRAFTED APPLE TREE

In connection with this cast-iron beam matter, Mr. Osborne suggests to me an illustration which I would not have thought of. Out here in an orchard, not mine, but one out of which I have picked a good many apples, there is a tree under which you can find today at least six kinds of apples. When I was a small boy I helped put in 14 different kinds of grafts in this one tree. Some of them lived, some did not; but if you should order a barrel of apples from this tree, you would know just about as well what you would get as they know at the foundry, just across the alley from where I am writing, what they will get when they open up their molds. They get iron castings, made of a mixture of various things, about which they know little. They buy their iron by analysis, but when they have it analyzed by two or three men who have samples from the same pig, they get just as many different results as they take samples. They have a pretty good foreman, and they can turn out test bars that break very evenly. But when you get them in a talkative mood, they admit freely that their test bars give them a pretty good idea of whether what they are buying is running even, but not much of an idea about what they are selling. That is, on a plain square section, poured in the same way day after day, it is easy to get similar results; but on complicated pieces, where so many complications may arise, they do not pretend to know much other than that they usually get castings "true to pattern."

THE UNCERTAINTY OF CAST IRON PARTLY COMPENSATED FOR BY ITS CHEAPNESS

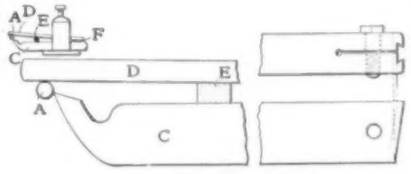
Mr. Osborne is right in saying that cast iron is our most valuable metal; but he ought to go on and say that it is so because superfluous strength usually is not detrimental to the working of machinery, even if accompanied by extra weight, provided the price is low enough. Cast iron lends itself so readily to duplication, can be gotten at such short notice, that its vagaries can be passed over. It is a good deal like the servant girl, an awfully poor lot, but cheap, and we have to have them. Some day I expect to see cast iron made like steel, from pig iron out of which the carbon has been burned, and then replaced in known quantity. It will cost a little more, but if we can find out how to control the combined carbon, it may help us out of a hole.

EDUCATION—DIGGING VS. SKIMMING

Finally, as the minister said, I beg to differ with Mr. Osborne about education. It sounds very well for him to advise the practical man to tumble in at the top and skim off what he can. But just as soon as a man begins to apply this sort of knowledge to anything off the beaten track, he will flounder. Hand-book knowledge, with nothing back of it, is a house built on the sands. If you want to get to the bottom of things, dig, dig, dig. Get out your old papers; think for yourselves. Don't be content to use any tools that you cannot take to pieces and put together again. Understand what logarithms are, some day you will get stuck badly if you don't know, and try to depend on them. And the more you get to know, the more you will appreciate the fact that those who know the most usually have the least positive information to give, which fact is illustrated by Mr. Osborne, when he finds his authorities in doubt. ENTROPY.

Turning a Small Rod in a Large Lathe—A Threading Tool

I once needed a long 5/16 inch drill to drill a boring bar from the end to the cutter seat, in this case a distance of 18 inches. All the small lathes were full and I had to take a 24-inch one. A piece of 3/8-inch machine steel had been welded on to a 5/16-inch twist drill, and had to be turned a couple of thousandths less than 5/16 inch the full length. I caught the drill end in the chuck, by blocking each jaw with a narrow strip of brass, the other end being centered ran on the tailstock center, and in between the atmosphere



THE TWO TURNING TOOLS

hardly gave it sufficient support to keep it from sagging in the middle. I arranged my tool as at Fig. 1, *A* being the drill, *C* the tool and *D* a piece resting on points *E* and *F* so that the space between the cutting point of the tool and piece *D* will just keep the work in place when the lathe is running. This has to be very carefully set, and it is well to grind a slight indentation at *G* to fit the curve of the work, as this helps to keep it from sliding away from the tool if it is not perfectly sharp. Of course a heavy cut cannot be taken, and the rig is only suggested for the benefit of those who may be in the fix I was in.

A THREADING TOOL

Fig. 2 shows a home-made threading tool which may be old to a few, but will prove a time and money saver in a small shop where there are any old three-cornered files. A piece of machine steel to fit the tool rest is slotted with a hack saw about 1½ inches back from the nose. A cap screw is set at right angles about the center of the stock to draw the slot in as required. The nose is chipped and filed (or shaped) to any desired bevel, to receive one size of old files ground

smooth on two sides. If the third side is left rough it insures a better grip with the holder. This makes a very handy threading tool, if care is taken when grinding not to lose the file temper, the 60-degree angle of the file of course corresponding with the standard V threads.

Canada. W. L. McL.

Suprising Figures with Respect to Cast-Iron Beams—A Defense of the Bach Formula

I think the craft should be thankful to Mr. Osborne for bringing up the question of cast-iron beams. Everybody that has had anything to do with the subject of predetermining the strength of cast-iron structures, will agree with him that there is, as a rule, no reliance to be placed on popular reference and pocket books. He has shown this, I think, pretty conclusively. On the other hand, this very state of affairs would make it seem desirable that some way be found that would enable a designer to at least approximately figure the strength of cast-iron structures.

THE RATIO BETWEEN THE COMPUTED TRANSVERSE STRENGTH AND THE ACTUAL TENSILE STRENGTH

To this Mr. Osborne will doubtless agree, as he himself gives, at page 524, a handy pointer in the right direction. The gist of the whole question is that "relation between the transverse and the tensile strength" which he advises to establish in every particular case, if practicable, that is, if a testing machine for both bending and tensile tests is within reach. For all those that are not so fortunate—and among these are the countless designers that are not in control of the foundry that is finally to make the castings for their designs—he puts that relation in the form of a constant ratio:

$$\frac{S_b}{S_t} = \frac{10}{4} = 2.5.$$

THE RATIO IS AFFECTED BY SEVERAL CONDITIONS

As I said above, this is a pointer in the right direction, but it is not enough. The aforesaid relation between transverse and tensile strengths of cast iron is really a coefficient that is meant to take care of the shifting of the neutral axis, due to the different behavior of cast iron under tension and compression, and is not constant, not dependent alone on the material, but also on the shape of the cross section and on the existence or non-existence of the scale, all as I pointed out at page 385, on good authority. I say good authority, because Professor Bach is recognized as such *in his own country*, and by *practical men, men of the shop*—which is saying much—and is not a mere theorist, but a man who went to the lecture room from the shop after a busy life in practical work.

APPLICATION OF PROFESSOR BACH'S FORMULA

It is just that "relation between transverse and tensile strengths" that he wished to establish by his numerous experiments referred to, and I have given, at page 385, the results. To these, I am forced to say, Mr. Osborne does not give the attention they deserve. In trying to refute their value he does not apply the formula embodying them, $S_b = \mu \sqrt{\frac{a}{z}} \times S_t$, for finding the tensile strength, but stops at figuring the transverse strength, and thus misses the very point.

At page 524 he speaks of three test pieces 2 inches wide by 1 inch deep broken 24 inches between supports, the breaking loads having been respectively 2650, 2650, 2200 pounds, and says that by Bach's formula, which I gave, the tensile strength would figure up from those breaking loads to be nearly 48,000 and 40,000 pounds respectively. Now as a matter of fact with $\mu = 1.2$, $\frac{a}{z} = 2$, they figure up to 28,400 and 23,600 pounds respectively, and not to 48,000 and 40,000, which is the transverse strength (S_b).

Again Mr. Osborne says that his regular test pieces 1x1 inch break at 12 inches between supports at about 2600 pounds, from which in refuting Bach's formula he figures the probable tensile strength to be nearly 47,000 pounds (growing at the end of his letter to 57,000), while it actually does figure up to about 28,000 pounds.

It is mainly to call attention to the above misunderstanding on the part of Mr. Osborne that I asked permission to again appear in print on the subject because I do not think it fair to leave an impression as if the conclusions drawn from a vast number of experiments made by an eminent engineer in one of the best equipped mechanical laboratories of the world were ridiculous and unworthy of attention. The constants for μ that Bach recommends, as well as his formulas, have proven so serviceable and correct in such an abundance of cases that I would stick to them although they do not seem to pan out right in the few cases that Mr. Osborne cites. We know nothing of the material of his tests except that it was just cast iron of a certain tensile and transverse strength, bearing in the case of those 2x1-inch pieces the ratios: $\frac{S_b}{S_t}$ =2.33, 2.46, and 2.5 respectively. This gives us no clue to the other properties, mainly the elasticity (under compression) which is the principal influence upon the shifting of the neutral axis or, what is the same thing, the magnitude of the ratio $\frac{S_b}{S_t}$. The constants for μ in Bach's formula are based on a material that answers to the following conditions which are deemed reasonable for a cast iron of all around usefulness in machine construction: A test bar cast in dry sand in inclined position with a head of 15 centimeters, of a cross section 30 millimeters square, unfinished, shall, when tested 1000 millimeters between supports, stand a deflection of about 18 millimeters before breaking, of which 1.5 to 3 millimeters are permanent. The permanent deflection may be looked upon as a measure of toughness, the elastic deflection as a measure of elasticity. The transverse strength (S) should not be less than 2200 kilograms per square centimeter (31,300 pounds per square inch). [As a rule this transverse strength lies between 2200 kilograms and 2700 kilograms (31,300 and 38,400 pounds)]. Tensile strength not less than 1200 kilograms (17,000 pounds).

In comparison with this material it would seem that the cast iron which Mr. Osborne used in the three 2x1-inch pieces is about the same, or a little stronger in tensile strength (20,600; 19,500; 15,700) but greatly stronger in transverse strength (48,000; 40,000) so that it is fair to assume that it is a good deal less elastic, which would account for the large ratio (2.5). From this ratio (2.5) we may figure μ from Bach's formula,

$$S_b = \mu \sqrt{\frac{a}{z}} \times S_t,$$

to be, with

$S_b = 48{,}000;\ 40{,}000$

$S_t = 20{,}600;\ 19{,}500;\ 15{,}700$

$\frac{a}{z} = 2$ (rectangular section)

$$\mu = \frac{S_b}{S_t} \times \frac{1}{\sqrt{2}} = 1.65;\ 1.74;\ 1.77$$

(av. 1.7).

Now coming back to the original test pieces of T section that started the discussion, and assuming the material they were made of to have been of similar material as that of which the 2x1-inch pieces were made, the tensile strength would figure up from the transverse breaking load to 24,700 pounds about, which is reasonable enough. Mr. Osborne's constant 2.5 would give in case 1, 23,300, and in case 2 21,600. Again his regular test pieces of 1x1-inch section that break at *about* 2600 pounds would under the same conditions indicate a tensile strength of about 20,000 pounds. Mr. Osborne's constant would give 19,000.

Of course a much closer agreement of the results cannot well be expected with all the "nearly" and "about" as to the data given, but the results do show that the proper method to employ in determining the relation between transverse and tensile strength is one that takes care of the material as well as of the cross-section; in short, some such method as Bach proposes.

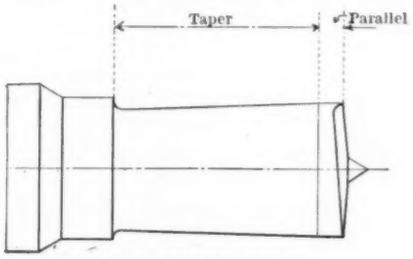
PRACTICAL VALUE OF THE BACH FORMULA

In conclusion I wish to emphasize another point and that is the practical side that attaches to the values which Mr. Bach recommends for his constant μ. When used to determine the probable tensile strength from given transverse break-

ing loads they may—for certain kinds of cast iron—bring the former up too high. But on the other hand, assuming a reasonable tensile strength, say 25,000 pounds, as a designer has to do, he will be sure and safe that he will not tax his structure with too great a breaking load, and to be on the safe side should always be the aim in proposing such constants as Bach does, should it not? As a matter of fact, to quote from his excellent book "Machine Elements," in which his experiments are digested for practical use, he says: "The experiments yielded in the average somewhat larger values for μ; in view of the *purpose* of our calculations of the strength of materials, however, it would appear more correct to enter into them values of μ rather too small than too large." PETER PALMER.

Force Necessary to Strip Work from Punches

At page 543 AMERICAN MACHINIST, Mr. MacDonald gives us some very interesting particulars of the power required to strip work from punches. He says he found by experiment that it required 2000 lb. to strip a 5/8-inch plate from a punch 23/32-inch diameter, without any taper. This seems enormous, and would hardly have been believed without experiment. It proves that something ought to be done to decrease this friction. To do as Mr. MacDonald suggests, is to have a punch with 1 degree taper, but though this only required 780 lb. to strip, its life would be short, on account of grinding altering its size. It occurred to me that if a punch were made like the illustration with the first ¼ inch or say 3/16 inch made parallel, the remainder having the 2 degree taper, the punch would strip at a rather low figure, besides having ¼ inch for grinding. I don't say that it would require less force than the punch with the 1 degree taper, still it would not take the 2000 lb. and consequently would not be so liable to break. If Mr. MacDonald has time to make a punch of this style, and experiment, I am sure many of your readers would be glad to know the result. There is still quite a lot to be learned about punch and press work. CONRAD.



THE PROPOSED PUNCH

An amount of electrical energy equal to a kilowatt-hour will run an electric clock for ten years.

The First Use of the New Engineering Building—A. S. M. E. Affairs

On the evening of November 22, the first use of the new engineering building given by Andrew Carnegie to the engineering associations of the United States took place in the form of what was called the first "Founders'" feast; this was a dinner given by the committee which has had the building in charge to the councils, or the governing bodies of the three technical societies which have had charge of the enterprise.

At five o'clock the guests assembled for an inspection of the new building, which has progressed far enough toward completion so that a very good idea may be obtained of it and of its splendid adaptation to the purposes for which it has been erected. The main auditorium, which, though not yet completed and still full of workman's stagings, was lighted and in condition to be fairly judged, was especially admired, and is believed to be by far the finest, the best lighted and generally the best auditorium possessed by any technical or professional society in the world.

Six tables had been placed in one of the smaller auditoriums on the upper floor, which had been tastefully decorated for the occasion by the architects. After the dinner Charles F. Scott opened the proceedings by placing the meeting in the hands of J. D. Hague, who acted as chairman and toastmaster. J. W. Lieb, R. W. Pope, R. W. Raymond, T. C. Martin, Ambrose Swasey and Fred W. Taylor spoke on various subjects connected with the undertaking and the construction of the building, Messrs. Raymond, Lieb and Swasey speaking particularly of the attention it has attracted among the engineers of foreign countries, whom they had recently visited.

Among the other interesting announcements was one by T. C. Martin, in the shape of a letter which he had received from George Westinghouse, announcing the gift on behalf of the various Westinghouse interests of $50,000 to be divided equally between the three societies and applied to the land fund. A great deal of enthusiasm was shown for the building, for the prospects of successfully fully financing the land question, and for the condition of the participating societies generally.

Previous to the dinner a meeting of the council of the American Society of Mechanical Engineers was held in its council room, which is practically completed, and at which various affairs of the society were discussed.

At this, the first council meeting in the new building, it was made clear that the society's affairs are in thoroughly competent hands, and members at a distance from New York and who may be unacquainted with all the circumstances that have lately arisen may rest assured that there is no serious difficulty with the society's affairs and no difficulty of any kind that cannot be easily taken care of. There is every prospect of a successful and enjoyable meeting. The following members of the governing bodies of the various societies were present at the dinner:

Bion J. Arnold, A. H. Armstrong, Geo. H. Barrus, J. J. Carty, Gano S. Dunn, James Gayley, F. L. Grammer, J. D. Hague, Geo. A. Hamilton, H. M. Howe, C. Wallace Hunt, F. R Hutton, J. F. Kemp, Chas. Kirchhoff, P. M. Lincoln, J. W. Lieb, R. C. McKinney, E. D. Meier, Fred J. Miller, H. D. Hale, H. G. Morse, E. E. Olcott, R. W. Pope, R. W. Raymond, T. C. Martin, Samuel Sheldon, Paul Spencer, H. G. Stott, Jos. Struthers, Ambrose Swasey, Chas. F. Scott, Fred W. Taylor, C. A. Terry, Calvert Townley, H. Westinghouse, Wm. H. Wiley, T. Wolcott, Walter Wood.

As having a bearing on the subject recently discussed in our columns as to why machinists do not read, we have a letter from a man holding a responsible position in a well known manufacturing establishment in New England and who, in discussing other things, says at the foot of his letter, "I commenced to read the AMERICAN MACHINIST in my cub days, nearly thirty years ago, and ever since I graduated from an apprentice I have regularly read it. I have been helped also in later years by articles appearing in it from time to time, and as long as I read anything I expect to read IT."

There is in this no explanation of why machinists do not read, but there is perhaps an explanation of why many of them do read and why others of them ought to.

The new factory of the Whitney Manufacturing Company, Hartford, Conn., which was started last June, is now nearing completion, and work has been commenced on erecting the shafting, etc., on the ground floor. The building is of reinforced concrete construction, of four stories, the main portion of the building being 226 feet long by 60 feet wide. These new quarters will nearly double their capacity.

It is stated that the Ridgway Machine Tool Company, of Ridgway, Penn., has been purchased by the Niles-Bement-Pond Company, of New York, which company has also recently increased its capital stock to a total of $10,500,000, the increase of $3,500,000 of common stocks to be used in extending manufacturing facilities at its various plants. We understand that a point had been reached at which the financial backers of the Ridgway concern were confronted with the alternatives of putting more capital into the business or of selling out, and chose the latter.

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To the Readers of the American Machinist—Help Wanted

The Third Assistant Postmaster General says trade papers such as the AMERICAN MACHINIST are in no way educational and he wants them debarred from the mails as second class matter.

This paper goes now at one cent a pound, amounting to about 48 to 50 pounds per year to each subscriber, which we pay for. Mr. Madden wants a new rate of "at least" 4 cents a pound, or the abolition of the second class altogether. Such a rate would take the profit all out of the publication or make it necessary to increase its subscription price.

Country political papers go *free* in the county in which they are published and are "educational"—about election time.

Whatever they do about the postage we want to convince Mr. Madden and the congressional committee that the AMERICAN MACHINIST, at least, is considered by its readers to be of educational value. We know that it has been a source of information of great value to men who make machinery the world over and we would now appreciate a brief letter from a lot of them stating what it has done for them or their concerns in the way of pure information not otherwise obtainable.

These letters will be used only for the purpose of convincing the committee.

Our postal affairs are in a curious state. The postal officials do not recommend a decrease in the rates paid to railroads for hauling the mails, said rate being many times the rate given to express companies for the same or similar service.

The Post Office Department carries millions of pounds of mail matter from the other departments of government and from Congress without pay (22,163,413 last year) and it expended many millions ($73,859,844.05 last year) on rural free delivery.

There is, naturally, a deficit and they want the publications of the country to make this up.

It is the subscriber who enjoys the advantage of cheap postage—and ought to keep it.

The trade publications of America are an important part of our commercial system and are established on the present rate.

Canada carries her papers free within 50 miles; at one quarter of a cent a pound for 300 miles, and above that at one half cent a pound—and makes a profit of half a million dollars a year instead of a deficit. Besides this Canada can and does send her papers all over the British possessions, *the United States* and Mexico at less than half it costs Americans to send their own papers at home.

Our readers can help us make this point emphatic by writing us a letter saying what they think of this paper as a source of useful information. Will you do it?

A Fly-wheel Accident Caused by a Curious Chain of Circumstances

Those of our readers who have followed the very interesting "Engineering Reminiscences" by Charles T. Porter, which have been published in our columns, will recall his reference to certain engines of his design which were installed in the works of the Otis Steel Company, at Cleveland, about 25 years ago. At the time these engines were installed, it was a notable order, and the engines have, ever since their installation, behaved themselves in a way to fully justify the pride of their designer in them. By what appears to be a strange coincidence, however, one of them has been recently wrecked as a result of a peculiar train of circumstances, and in such a way as to make it clear that no one is to blame for it; in other words, that it is one of those unfortunate occurrences which will occasionally happen, in spite of the most complete precautions to prevent it.

The engine in question, a 40x48 in., running normally at 100 revolutions per minute, and with the governor driven by a belt, started to run away, owing to the breaking of the governor belt. The engine had been equipped with a well known and thoroughly tried automatic safety stop, so arranged as to close the throttle by means of a chain-driven sprocket wheel, when the normal speed was exceeded by any considerable amount. The engineer, however, who was near the engine when the governor belt broke, became aware, either by observation of the broken belt or by a noticeable increase of speed, that something was wrong, and rushed to the throttle valve to shut off steam. In doing so, he passed his arm through the opening between the two sides of the sprocket chain, with the intention of tripping the safety stop, but before he could do this the safety stop itself acted, and the first thing it did was to catch the engineer's arm between the chain and the sprocket wheel; which resulted in two things: First, it prevented the complete closing of the throttle valve by the safety-stop device, because its operation was blocked by the engineer's arm. Second, the engineer's arm was so firmly caught and held that he himself could not shut down the engine, and its speed continued to increase until an oiler, who was near by, at the risk of his life, ran to the assistance of the engineer and succeeded in closing the throttle; but not until the speed had increased to such an extent that the fly-wheel was ruptured. A piece of it, consisting of one of the arms and a complete joint with links, and weighing several hundred pounds, was projected through the roof of the building, and for a distance of 800 feet, to the roof of a frame dwelling house, which it partially demol-

ished, and both the engineer and the oiler were severely injured.

The wheel weighed 48,000 pounds, and was built in eight sections, held together by through bolts at the hub, and by steel loop links shrunk over lugs cast in the rim, three of these links being used at each joint; one at each side and one inside the rim, which was 10 inches wide and 12 inches thick. Both in construction and in material the wheel is pronounced to have been as good a job as it is practicable to make, and it is believed that nothing short of a very great excess of speed, such as took place, would have caused it to fail.

Here is a case wherein neither the designer, the foundryman, the machinist, the management of the mill in which the engine was running, nor the man in charge of it seem to have failed in any particular, so far as doing their whole duty was concerned, and yet the fly-wheel was ruptured with disastrous results.

It can be seen now that a guard should be placed about the sprocket wheel of these safety devices in such a way that neither the engineer's arm nor any other object can prevent their operation; but such an occurrence as took place could scarcely be anticipated, and no blame can attach to anyone for not anticipating it.

New Publications

"A Course of Instruction in Engine and Boiler Design." By J. D. Hoffman. 38 8¼x11-inch pages with 35 text cuts and 4 full-page illustrations. The Burt-Terry-Wilson Company, Lafayette, Ind.

This pamphlet is a condensed collection of formulas and data arranged for the use of the students of Purdue University. All essential points are covered, the data used being from the most recent sources.

"Marine Engineers and How to Become One.'" By E. G. Constantine. 332 4¾x7-inch pages, 84 illustrations.

An excellent book, well written and interesting, full of valuable information and suggestions for marine engineers of all ranks. Reciprocating marine engines and marine boilers are pretty fully covered, but little mention is made of turbines. This is not surprising as those best informed on this subject from the operating engineer's standpoint seem to be peculiarly reticent. The paper, printing and illustrations are good. The Technical Publishing Company, Ltd., Manchester and London. D. Van Nostrand Company, New York. Price $2.

"The Mechanical World Pocket Diary and Year Book for 1907." 302 4x6-inch pages with numerous illustrations and tables. Emmett & Company, London and Manchester. Price, 6 pence.

This, the twentieth annual edition of a well known pocket book, appears in a thoroughly revised form. It has been entirely reset in new and clear type, and while some of the less important sections have been condensed, others have been enlarged and a number of new features have been added. There are new sections on gas and oil engines, suction-gas producers, and reverberatory furnaces. Other sections have been enlarged and new tables and illustrations introduced. Those of our readers who have recently called for a shop pocket book might go farther and fare worse than by buying this one. If they do not find everything they want, they will not, in view of the phenomenally low price, complain.

"Preliminary Report on the Operations of the Fuel-testing Plant of the United States Geological Survey at St. Louis, Mo., 1905." Joseph A. Holmes in charge. 240 6x9-inch pages. The Government Printing Office, Washington.

Authority for continuing the investigation of fuel values inaugurated at the St. Louis Exposition in 1904 was given by an act of Congress passed March 3, 1905, by which the sum of $202,000 was appropriated for this purpose. The present preliminary report covers the work done from May 1 to December 31, 1905. The plant at which the investigations have been carried on remains in its original location. Two buildings left by the exposition have been added to the plant, and other facilities have been increased. Many of the experts who were in charge of the investigations in 1904 have been continued in charge, and a number of additional assistants have been engaged. The tests include chemical analyses; washing tests to determine the possibility of improving the quality of the coal; coking tests to determine the possibility of making or improving the quality of coke made from the coals; gas-producer tests to determine the efficiency of each coal for this method of power production; steaming tests to determine the value of the coals for steam generation; briquetting tests to determine the extent to which the fines or slack coals can be economically made into briquets. The results of these tests are to be discussed more at length in a later and more complete report. Meanwhile the present report contains chapters which describe the manner of conducting the various tests and detailed reports of the tests in tabular form. No tests comparable with these in completeness have ever been made, and the report will no doubt be in large demand by engineers. It can be obtained by addressing the Geological Survey, Washington.

A Shop House Warming

The new factory of the Jones Speedometer Company, at New Rochelle, N. Y., was dedicated with a house warming on Saturday evening, November 17. A special train conveyed the guests from the Grand Central Station, New York City, and also brought them back after the festivities were concluded. After an inspection of the factory, the guests assembled on the top floor, which had been cleared of machinery for the occasion, and chairs arranged for the visitors. At one end of the room a stage was erected, and a vaudeville performance was given, after which supper was served.

Inspection of the factory revealed the fact that it is in every way an admirable plant. The provision for the comfort and preservation of the health of employees is of the highest order; the machine tools are of the best quality, and competent men are in charge of things.

Reforms Needed in the Patent Office

It is announced that the Commissioner of Patents, with the sanction and indorsement of the Patent Law Association, of Washington, is about to issue an address or statement to the industrial and manufacturing interests of the country, dealing with the complaints that have been made regarding the conduct of the office, and particularly with respect to delays which occur in handling patent applications. It is understood that the commissioner will particularly recommend a considerable increase of the salaries of examiners, which are now $2500 a year, as a maximum, beginners having to start much lower. It is found in practice that private concerns employ the best men after they have gained some experience in the office, so that the department is continually losing its most efficient examiners, and the work is thereby greatly impeded. Additional room, it is also declared, is imperatively needed for the proper conduct of the work of the office, and the lack of it is a serious detriment to industrial and other interests.

An Impostor Sent to Prison

A man by the name of J. B. McDonald, alias J. B. Kennett, who has been fraudulently representing himself as an authorized solicitor of subscriptions for the AMERICAN MACHINIST and other technical publications, has, through the efforts of *The Engineer*, of Chicago, been caught at Niagara Falls, N. Y., and sentenced to the Erie county penitentiary.

We caution all subscribers and prospective subscribers not to pay any money to anyone claiming to represent the AMERICAN MACHINIST or the Hill Publishing Company, unless the solicitor shows a credential letter signed by the auditor of this company, and limited to three months from its date.

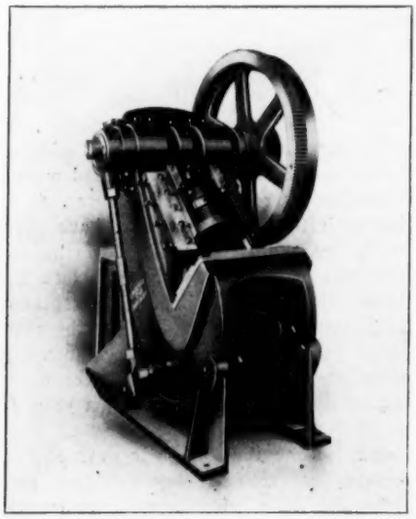
It is announced that the American Society of Mechanical Engineers will hold meetings on the second Tuesday of the months of January, February, March and April.

NEW TOOLS AND MACHINE SHOP APPLIANCES

AN ARMATURE-DISK CUTTING PRESS

The illustration shows a press designed to produce motor and dynamo armature disks economically.

This machine is fitted with positive knockouts for both the punch and the die. These absorb no power unnecessarily, and are



AN ARMATURE-DISK CUTTING PRESS

to be relied upon. The slide is very long and accurately fitted, to give perfect guidance to the delicate dies which are to be operated in the press, and it is connected with the shaft by two solid pitmans, which evenly distribute the load. There is a special adjustment in the mandrel so as to accommodate various hights of dies. The upper knockout is stationary, and is between the two pitmans. It acts positively against the knockout plate in the mandrel, which in turn acts against the knockout pins in the die (holes for these pins are shown in the mandrel). This knockout has screw adjustment to compensate for any adjustment that may be made in the mandrel.

The lower knockout is actuated by an eccentric cam on the shaft, which gives motion to the knockout levers by means of a long connecting rod, which also serves to adjust the travel of the knockout plate. The knockout levers are fastened to the lower shaft and raise the knockout plate on the up stroke of the slide. The plate is guided by two rods to keep it perfectly level, so as to have a uniform pressure on the knockout pins in the lower die.

To eliminate the handling of the punched disk the press is set on an incline, and as soon as the piece has been discharged from the die, it falls through the back of the press, while the upper knockout frees the scrap from the punch and enables the operator to proceed to make another disk.

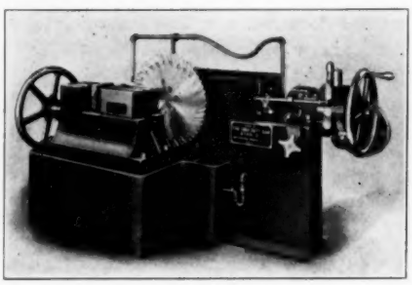
The total weight of the press is about 5000 pounds, and it is adapted for cutting disks complete with outside notches, center hole and key slot up to 10½ inches diameter, or it will cut plain disks with center hole up to 12 inches diameter up to No. 23 Stub's gage. The press is direct-driven by an electric motor. The motor table is seen at the back of the press.

This press is built by the E. W. Bliss Company, 1 Adams street, Brooklyn, N. Y.

A HIGH-DUTY COLD SAWING MACHINE WITH SPECIAL TABLE VISE

It is essential when high speeds and heavy feeds are being taken with cold saws, or in fact any other tool, that the work should be firmly held. Any vibration of either machine or work is fatal to rapid work and destructive to the cutters. To secure rigidity in the work, the combined vise and table shown in the illustration was designed.

The vise is secured to the adjustable platen of the machine. A tongue in the fixture corresponds with a slot in the



A HIGH-DUTY SAW WITH VISE

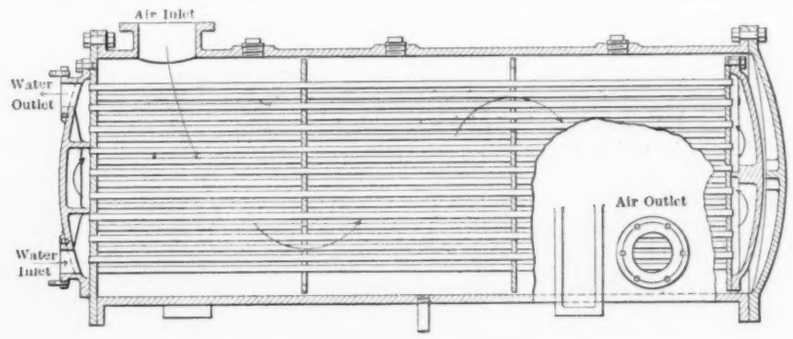
platen and bolts from the T-slots in the platen secure the two together.

The fixture itself is a combination vise and table. The upper part has a block moved by means of a screw and hand wheel. When the block is brought in contact with the front part of the fixture a solid table is provided on which work can be bolted. Special jaws can be inserted in the faces of the block and table for holding bar stock, etc. T-slots are provided as shown, for clamping work on top.

This fixture is made and applied to their cold-sawing machines by The High Duty Saw and Tool Company, Eddystone, Penn.

INTERCOOLER FOR AIR COMPRESSORS

The accompanying illustration shows a recent design of air-compressor intercooler which has been adopted by the Allis-Chalmers Company. Its special feature is the arrangement of the right-hand head whereby independent expansion and contraction of tubes and shell are permitted.



AIR-COMPRESSOR INTERCOOLER

In addition to this the air space will be seen to contain a pair of baffle plates, open alternately at top and bottom, whereby the air is compelled to pass across the tubes three times. Another feature will be seen in the ribs inside the end-water spaces, whereby the water is compelled to pass through the tubes in series.

Without such ribs the water has a tendency to select some of the tubes and ignore others, the cooling effect being thus reduced. The air space will be seen to be external to the tubes, an arrangement which puts the larger outside surface of the tubes next the air where it is most needed.

The difficulty of surveying deep bore holes has been overcome by photography in South Africa, an apparatus devised by William Helme, of Johannesburg, having given accurate results in that not only the vertical drift of the hole, but also the position of the magnetic needle is recorded. The apparatus consists of a long brass cylinder which contains a small watch, a dry battery, two miniature electric lamps operating in connection with a compass supported on gimbal bearings, and a suspended plumb bob; at a predetermined time the watch makes a contact lighting the lamps, by means of which the positions of the plumb and the magnetic needle are photographed on a small disk of sensitized paper.

A MULTIPLE MOLDING MACHINE

A New and Economical System of Molding Small Pieces

EDITORIAL CORRESPONDENCE

In making an element of a multiple mold it becomes necessary to form the lower or drag-mold face on the upper surface of the mold element at the same instant that the upper or cope face is formed on the lower surface of the single block of sand in its flask, which constitutes one of these mold elements as shown in Fig. 3. Many attempts have been made to do this with a view to piling the molds on top of one another and pouring them simultaneously. The fundamental difficulty of the process lies in impressing a pattern into the top or drag surface of the sand and, because of this, using ordinary methods, it has been found to be impossible to make satisfactory drag molds except from patterns having very flat drag parts.

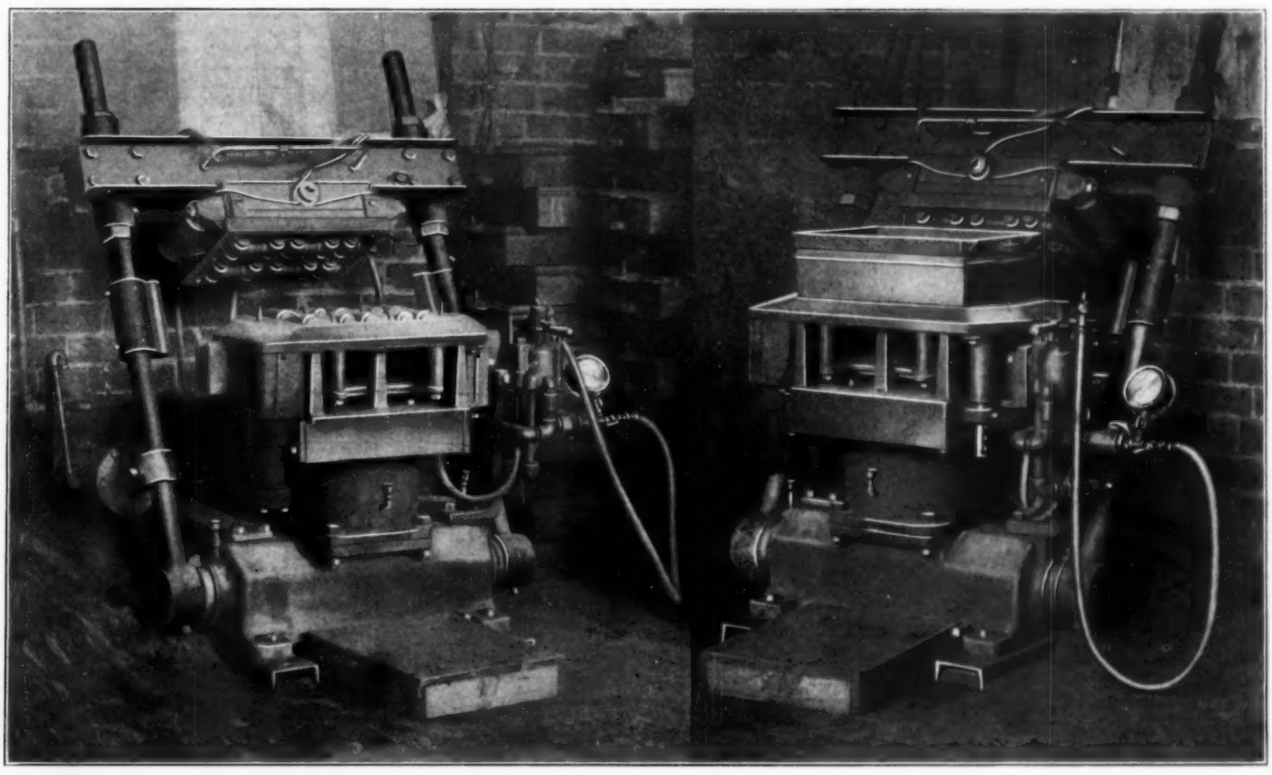


FIG. 1. THE MACHINE WITH TWO SETS OF HALF PATTERNS

FIG. 2. THE MACHINE WITH FLASK AND SAND FRAME IN POSITION

THE METHOD AND MACHINE DESCRIBED

The accompanying illustrations show a machine embodying a new method of doing this work, by which the difficulty is surmounted. The method consists in attaching the drag parts of the patterns to the ramming yoke and then swiftly raising the flask and sand against them, the effect being to throw the sand upward against the patterns precisely as it is ordinarily thrown downward by gravity and thus fill the spaces among the patterns.

Fig. 1 shows the machine with the cope parts of the patterns attached to the pattern plate of a split-pattern vibrator machine in the usual way and the drag parts attached to the ramming yoke as has been described. Fig. 2 shows the machine with a flask section in position and on top of it a sand frame which is of such depth that when flask and frame are filled to the top and struck off the contained unrammed sand is proper in amount to fill the flask alone when rammed. The sand being in place, the ramming yoke is swung to the upright position and an air valve is opened, admitting a charge of compressed air from a reservoir to the cylinder of the machine. This reservoir is close to the cylinder with no long ports or pipes connecting them. The admission of air is thus very abrupt and consequently the flask, sand and cope patterns are suddenly and violently thrown upward against the patterns on the ramming yoke, the result being the impacting of the sand among the drag patterns and the immediately subsequent ramming of the entire body of sand between the cope and drag patterns, all in the fraction of a second. Both ramming yoke and platen have vibrators attached. As the machine rams, the upper vibrator is started automatically and as the flask and sand fall back the drag patterns are drawn from the sand while the sand frame is caught by electromagnets or spring catches attached to the ramming yoke and thus removed from the flask. The cope patterns are then drawn from the under side of the flask in the usual manner.

STACKING THE MOLDS

The operator next lifts off the mold element and, if it be the first one, he places it, regardless of its bottom or cope face, on a suitable bed and proceeds with the second mold in the same manner, the sprue between the sections being formed automatically by the machine. The second mold is placed on top of the first one and others are added in the same way, the resulting multiple mold being shown in Fig. 3 and alongside it a gate of castings poured in this manner, the castings shown being of brass.

An obvious question regarding the feasibility of the process relates to the liability of the lower molds straining and thus giving heavier castings than those nearer the top. Such straining is not found to take place, the probable explanation being the chilling of the castings and especially of the gates as the pouring goes on, whereby the lower molds are protected from the full head due to the hight of the stack of molds.

SOURCES OF ECONOMY

The machine will be seen to involve several sources of economy, the most obvious being that of time due to making two molds at once. In addition to this is the economy of sand and flasks, figured, in the case of a nine-high mold, to be about 37 per cent. and the economy of floor space, figured for the same condition, to be about 88 per cent.

Owing to the fact that sand will not flow laterally under pressure, it is always necessary in order to secure the best molds, to hand-tuck and sand immediately about the patterns, though, on much of the molding required of machines at high speed this is not practised, as the quality of the work does not require it. When the sand in a multiple-mold element is tucked by either hand or machine process, the quantity of the sand in the flask becomes uncertain and, as the rammed joint

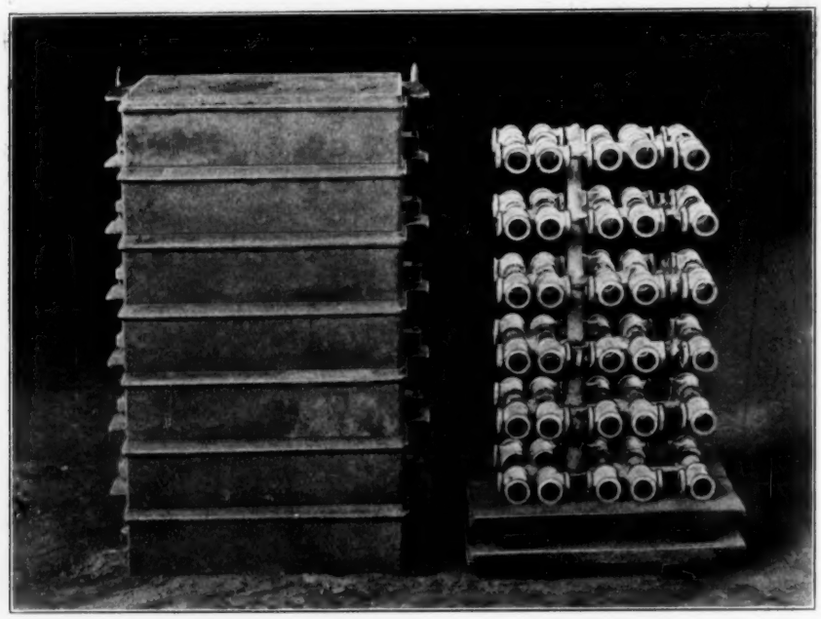


FIG. 3. THE MOLD AND A GATE OF CASTINGS

surfaces of the molds must never stand below the flask edges, it is usual to find them above by a small fraction of an inch, and it is an interesting fact that these open joints are very successful in multiple molding.

The process is the invention of A. Rathbone, of Detroit, Michigan, and the machine is made by the E. H. Mumford Company, of Philadelphia. F. A. H.

Personal.

E. C. Paschall, formerly of the Gautier Department of the Cambria Steel Company, has become associated with the A. P. Witteman Company, of Philadelphia, manufacturers of furnaces, forgings, and agents for the Burgess steels.

It is E. P. Bullard, Jr., who was elected one of the Board of Managers of the newly formed Society for the Promotion of Industrial Education instead of his father, as we had it in our report. Mr. Bullard, Jr., had been elected one of the representatives of the National Machine Tool Builders Association, but was unable to be present at the meeting.

Business Items

The Power Specialty Company, Detroit, Mich., has had the word "Diamond" incorporated in its firm name and will hereafter be known as the "Diamond" Power Specialty Company.

The Lapointe Machine Tool Company, manufacturers of Lapointe adjustable reamers and Lapointe keyseat broaching machines, has moved from Boston to its new plant at Hudson, Mass.

Manufacturers

The Vulcan Iron Works, Williamsport, Pa., will erect an addition.

The Watervliet (N. Y.) Foundry Company is erecting a new plant.

The Empire Metal Company, Syracuse, N. Y., is erecting a new plant.

The American Multigraph Company, Cleveland, Ohio, is erecting a new plant.

The Ludlum Steel and Spring Company is building a factory in Colonie, N. Y.

The Hill Trunk Company, Nashville, Tenn., will put up a new four-story factory.

The Home Packing and Ice Company, Terre Haute, Ind., will erect a $14,000 plant.

The Penn Shovel Manufacturing Company, Warren, Ohio, will erect a rolling mill.

The Jamestown (N. Y.) Packing and Provision Company will erect a new plant.

The Rensselaer (N. Y.) Valve Manufacturing Company is building an addition.

The Henry M. Glenn Wagon Company, Seneca Falls, N. Y., is building a new factory.

The Brantford (Ont.) Cordage Company will build an addition to the machine shop.

The Pennsylvania Iron Works, Philadelphia, Pa., will erect a plant in Eddystone, Pa.

The Vulcan Iron Works, Mason City, Iowa, is making arrangements to enlarge its plant.

The White Enamel Refrigerator Company, St. Paul, Minn., will erect a $15,000 addition.

The Hoopeston (Ill.) Canning Company is having plans drawn for a new $40,000 factory.

The American Die and Tool Company, Reading, Pa., is making several additions to its plant.

Todhunter & Alfs, Peoria, Ill., manufacturers of sash, blinds, etc., are erecting a large new plant.

The General Electric Company, Schenectady, N. Y., will erect a power plant in Schuylerville.

Michael B. Fahey, Chester, Pa., is forming a company for the purpose of erecting a cold-storage plant.

The Rochester (N. Y.) Railway and Light Company has filed plans for its new electric power station.

The Continental Can Company, Syracuse N. Y., will erect a plant in Baltimore, Md. and one in Chicago.

The Perot Malting Company, Philadelphia Pa., will erect a malting plant in Buffalo, N. Y., to cost $250,000.

Miscellaneous Wants

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad St., New York.

Wanted—Medium-weight specialties to build. Box 320, AMERICAN MACHINIST.

Wanted—A stamping press with a 5" strike. Powers, 343 East 63d St., N. Y. City.

Universal Test Indicator circulars free. H. A. Lowe, Lock Box 146, Cleveland, O.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machry. to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Dies and Diemaking, $1.00. A shop book by a shop man. J. L. Lucas, Bridgeport, Ct.

Novelty in tool or machine specialty wanted. Particulars required. Box 202, AMER. MACH.

Special machinery designed and built. Walter S. McKinney, M. E., 43 Broadway, Flushing, N. Y.

Working Drawings — Experimental work. Geo. M. Mayer, M. E., 1131 Monadnock Blk., Chicago, Ill.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Buyers of brass goods—Before placing orders see us for prices of castings and finished product. Good workmanship, prompt deliveries. S. J. Asbell Co., Paterson, N. J.

Boston manufacturers' agent wishes to represent established firm in this vicinity; will take on first-class line on commission basis. Address Box 367, AMERICAN MACH.

Special high-grade machinery built to order, automatic and otherwise; electrical work a specialty. Complete modern equipment. Automatic Machine Development Company, 130 East 12th street, New York.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Not using the whole of our modern factory plant, we should like to take up the building of any small high-grade machines, or parts of machines, in large or small quantities. United Sewing Machinery Company, Springfield, Mass.

Contract work—A large, well equipped foundry and machine shop in Ohio is open for contract work; moderately heavy work preferred, such as machine tools, engines, compressors, or any special machinery. Address Box 370, AMERICAN MACHINIST.

Foremen, toolmakers, draftsmen, machinists, etc., promptly furnished to employers free of charge. Business conducted on high-grade lines by practical men. We may have just the man you want. Macgregor's Engineering Agency, 432 Main St., Springfield, Mass.

Draftsmen, engineers, graduates, designers, learn automobile designing, including the lat-

est European and American practice; day and evening classes, and by correspondence; write or call for prospectus. Favary's Automobile Designing School, 1416 Broadway, New York.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

We have a modern up-to-date manufacturing plant and, having recently more than doubled our capacity, are in a position to take contracts for the manufacture of special tools, small high-grade machinery, or parts of machines in large and small quantities; we can refer you to a very well known line of high-grade tools now on the market to demonstrate that we are able to do the highest grade of interchangeable work. Will be pleased to furnish estimates upon receipt of drawings and specifications. Box 363, AM. M.

Business Opportunities

Wanted to contract with shop within 50 miles of New York City, equipped for making highest-grade automobile chassis. Must have capacity for at least 100 cars per year and able to do highest grade interchangeabe work cheaply. No body work. Box 210, AM. MACH.

British agency—A firm of engineers, with works and warehouses in west of England, London offices and agents throughout Great Britain and Ireland, are open to accept sole agency for American specialties in engineers' tools, etc. Address Frederick Avens & Co., "Trusty" Engineering Works, Stroud. Glos., England.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the construction of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Two second-hand cupolas in first-class condition; shells 72"—82" in diameter and about 40 feet high. Box 333, AM. M.

For Sale—Four new extra heavy and well made gasolene engines; can readily be used for gas; price $150. These cost $275 each. One new No. 3 Goulds rotary pump, 5-inch suction, $90; cost $135. Geo. Gorton Machine Co., Racine, Wis.

For Sale—One No. 2 Aurora plain back-geared dividing-head milling machine in first-class condition; also one 38"x12' screw-cutting lathe, manufactured by E. Harrington & Son, Philadelphia, in first-class condition. Box 351, AMERICAN MACHINIST.

For Sale—Established manufacturing plant in one of the largest and best middle West cities, consisting of machine, blacksmith and pattern shops, well equipped for every class of work and now engaged on a large amount of profitable contract, repair and special work; good reason for selling; cheap for cash, or terms to suit purchaser. Address Box 249, AMERICAN MACHINIST.

For Sale—Foundry and machine shop, electric, fully equipped; cost $108,000 to erect and equip; acquired upon debt; title good; centrally located; lies between two railroads; paved streets, electric lines, sewers, city water; solidly built of brick, fire-proof pattern storage, etc. A snap bargain. A portion of purchase price down, balance in deferred payments. Address The City Bank, Battle Creek, Michigan.

Wants

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CALIFORNIA

Mechanical engineer—expert on steam engines, marine and stationary, and air-compressor designing, erecting and testing—desires to change; 10 years' shop and drafting-room experience; Eastern States preferred. Reply to P. O. Box 299, San Francisco, Cal.

CONNECTICUT

Inventor (33), now employed, wants to change; typewriter or similar work preferred. Box 339, AMERICAN MACHINIST.

American, 35 years old, with 15 years' experience diemaking and foreman, is open for position as foreman of tool department or assistant superintendent; best reference furnished as to ability in workmanship and in handling help. Address Box 481, Waterbury, Conn.

MARYLAND

Young man, age 29—nine years' experience in drafting room on tools, automatic machinery, jigs and fixtures—desires change. Box 358, AMERICAN MACHINIST.

MASSACHUSETTS

Young man, 29, thoroughly up-to-date on Jones & Lamson and hand screw-machine work, wishes position as foreman or assistant of screw-machine department; South or middle West preferred. Box 368, AM. MACH.

NEW JERSEY

Foreman—practical machinist for building or repairing—wishes to make a change; I am now employed by one of the largest auto concerns in the city of New York. Box 352, AMERICAN MACHINIST.

NEW YORK

Mechanical engineer, with thorough practical training in design and manufacture of high-grade machinery, wishes change. Box 372, AMERICAN MACHINIST.

Natural executive and organizer, age 37, varied experience as general foreman of shops and master mechanic, invites proposals; state salary. Box 356, AMERICAN MACHINIST.

Wanted—By mechanical engineer, position as superintendent or manager of machine works; special ability in installing systematic methods of manufacture. Box 317, AM. M.

Toolroom foreman — practical, experienced toolmaker, foreman, and designer in large toolroom—desires change; interchangeable, rapid, productive tools, jigs, fixtures. Box 357, AMERICAN MACHINIST.

Wanted—Position by man, 27 years old, with general office, cost and factory accounting experience and has working knowledge of machine shop and foundry practice. Box 373, AMERICAN MACHINIST.

Position as works manager with company employing about 200 men; am desirous of associating with a company that wants to cut the cost of manufacture and increase their output; excellent executive ability, successful in the handling of men. Box 374, AM. MACH.

PENNSYLVANIA

Position as superintendent by thoroughly practical man; good executive, clever designer of special jigs and appliances; up-to-date on best shop practices and organization, cost and time work; at present in charge of large engine plant; first-class references. Box 364. AMERICAN MACHINIST.

WISCONSIN

Man with several years' experience at designing special machinery and tools wants a responsible position; technical, practical and reliable. Box 365, AMERCAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

ALABAMA

Machine-shop foreman—Must be familiar with the manufacture of Corliss engines and general line of heavy machinery; location in the South. Address Box 360, AMER. MACH.

CANADA

Wanted — An experienced tool designer, small interchangeable parts made in large lots; range of tools: punches and dies, jigs, milling fixtures, screw-machine fixtures and cams. A good opening for the right man. Northern Electric and Mfg. Co., Ltd., Montreal, P. Q.

CONNECTICUT

Wanted—First-class operator on Jones & Lamson turret lathe; also one first-class all-around machinist. The New Machine Co., Danbury, Conn.

Wanted—Tool makers, die sinkers, drop forgers and men familiar with grinding machines. Apply to D. P. Beckwith, Pope Manufacturing Company, Hartford, Conn.

GEORGIA

Wanted—Patternmaker used to Corliss engine and steam-pump work; good place for a man who means business. Address C. R. McGahey, Gen. Supt., E. Van Winkle Machine Works, Atlanta, Ga.

ILLINOIS

Wanted—A man of first-class ability as designer of intricate machinery and with some experience in charge of draftsmen; knowledge of jigs and fixtures preferred; concern is rapidly growing and the opportunities for advancement are unusually good; location is in a desirable residence city within 100 miles from Chicago. Box 344, AMER. MACHINIST.

Wanted — Machine-shop foreman familiar with manufacturing small interchangeable work; applicants will only be considered who are holding similar positions and who have records which will bear investigation; good wages and an excellent opportunity for advancement. If interested, write for further information; correspondence confidential. Box 355, AMERICAN MACHINIST.

A modern, progressive and growing factory, located in a fine city of moderate size, wishes to obtain the services of a designer of wide experience in accurate, complicated machinery, especially in difficult, automatic press work; the right man may expect a permanent position, with excellent future prospects; technical training, excellent record and reliable references are absolutely necessary; in replying, give an account of education and experience and state age, nationality, salary now received and salary required. Box 371, AMERICAN MACHINIST.

Wanted—A man between 30 and 40 years of age who has had charge of a large number of men on small machine work of the very finest character, and who can show a first-class record in such work, together with reliable references as to character and ability, and who desires to make a change with a view to bettering his position. Those interested are requested to send a brief account of training and experience, together with a statement of nationality, age and salary expected, to the address given below. All communications considered strictly confidential and returned to writer if requested. Box 343, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Metal patternmaker competent to take charge of metal pattern work; state age, experience and salary expected. Address Box 350, AMERICAN MACHINIST.

Mechanical draftsman for special work, involving machine designing and shop systematizing; $2000 per year. Write Y. M. C. A. Employment Department, Springfield, Mass.

Wanted—Good mechanical draftsmen with experience on high-speed steam engines. Address Engineer in Charge, Drawing Office, General Electric Co., West Lynn, Mass., giving full particulars regarding age, education, experience and salary expected.

A machine shop employing 300 hands, with enlargements under construction, is looking for a man to have immediate charge of the drafting room and do designing of a complicated character; a technical education, followed by some years of practical experience, with a first-class record, is required. Box 341, AMERICAN MACHINIST.

Wanted—A man thoroughly competent to act as assistant superintendent of an up-to-date machine shop, employing 500 men, on accurate, interchangeable work; concern is rapidly growing and prospects of advancement are excellent for the right man; the location is an ideal residence place, having most of the advantages and few of the disadvantages of a large city. Box 342, AMERICAN MACHINIST.

MISSOURI

Wanted—Machinists, electricians, engineers and firemen, do you want to "get wise?" Send for 52-page pamphlet containing questions asked by different Examining Boards; sent free. Geo. A. Zeller Book Co., 53 South 4th street, St. Louis, Mo.

NEW JERSEY

Wanted — Ten good machinists and six good millwrights. Apply to New Jersey Engineering and Supply Co., Passaic, N. J.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Superintendent—Corporation requires the services of competent man accustomed to the latest and best machine-shop methods and practice, capable of organizing and handling a

machinery plant in all its branches; preference given man able to design special and automatic machinery, tools, jigs and fixtures for the rapid and economical production of fine and medium heavy interchangeable work. Box 366, AMERICAN MACHINIST.

NEW YORK

Wanted—First-class draftsman; must be good checker; good opportunity for the right man. Box 349, AMERICAN MACHINIST.

Wanted — Experienced draftsmen, toolmakers and machinists; give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Wanted — Competent millwrights; applicants will state wages expected and when they can commence work. Address A. A. P. C. W., Alsen, Greene Co., N. Y.

At our new factory — Toolmakers experienced in fine and complicated work; steady employment and good wages. Jones Speedometer Co., New Rochelle, N. Y.

Wanted—A first-class department foreman capable of handling fifty men; must be experienced in instrument work; liberal salary to right man. "J. S.," AMERICAN MACHINIST.

Technial men everywhere in spare time. No goods to sell; no expense; professors, draftsmen and literary machinists thus far appointed; state experience. Box 334, AM. M.

Draftsmen on jigs and fixtures for duplicating work; none but experienced men wanted; good pay for right men. Mergenthaler Linotype Co., 20-42 Ryerson St., Brooklyn, N. Y.

Engine erectors wanted; those experienced with internal combustion engines and gas producers preferred; state experience and salary. De La Vergne Machine Co., foot East 138th street.

Wanted—First-class boring-mill hand for 96" mill; good pay to right man; factory located about 20 miles from Albany; state age, experience and salary expected. Box 353. AMERICAN MACHINIST.

Man wanted to represent us on the road; one acquainted with babbitt, solder and type-metal trade and preferably employed at present. This is a good opportunity for the right party. Box 266, AMERICAN MACHINIST.

Wanted—First-class lathe and horizontal boring mill hands on night shift, first-class floor hands day shift; no labor troubles; increasing force. Address, stating wages desired, Ingersoll-Rand Co., Painted Post, N. Y.

Wanted—One good man in every machine shop to sell Gre-Solvent to his fellow workers; five to twenty dollars weekly may be earned, according to size of shop. Write us, stating shop where employed. Utility Co., Room 100, 332 Broadway, New York.

Wanted—Thorough, all-around draftsman to act as checker; applicants must have had practical appearance in making dies, jigs, etc., as well as technical training; applicant must be able to report at once if accepted; give full information as to salary and experience in first letter. Address Box 359, AMER. MACH.

Wanted—Foreman for growing shop manufacturing instruments of precision by modern methods; must be a live man, well educated, up-to-date on modern manufacturing for duplicate parts, possess strong character and executive ability; unless you are positive you possess above qualifications, do not answer; state age, nationality, experience, wages expected, whether married or single, and give references. All correspondence strictly confidential. Address Precision E. X., AM. MACH.

OHIO

Wanted—Experienced man to superintend the erection of electric cranes. The Case Mfg. Co., Columbus, Ohio.

Several first-class draftsmen thoroughly familiar with steam-hammer designing; state experience, age and salary expected. Box 301, AMERICAN MACHINIST.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

Wanted—Mill draftsmen for architectural department, accustomed to making layouts for machinery and power departments; also high-class designing draftsmen for light machine tools, etc. Address, giving age, salary expected, etc., Box 337, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—First-class jig and fixture makers for small fine work; state age, experience and salary expected. Box 361, AM. M.

Wanted—Ten machinists, general machine and bench hands; also two A-1 patternmakers. Apply to Scottdale Foundry and Machine Co., Scottdale, Pa.

Wanted—Tool, die and instrument makers; also a number of operators on large machine tools. Address Employment Department, Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

Wanted—Fitters and vise hands for machine-tool work; steady employment and good wages to first-class workmen. Address Colburn Machine Tool Co., Franklin, Venango County, Pa.

The Stokes and Smith Company, 1011 Diamond street, Philadelphia, have a good position for a traveling salesman who has had experience in selling machinery. Box 369, AMERICAN MACHINIST.

Wanted by railroad supply house—Young railroad machinist, preferably with some knowledge of drafting, to work in drawing room or to attend to outside work when required; good opportunity to grow up with the business; state age, experience and salary desired. Correspondence strictly confidential. Box 354, AMERICAN MACHINIST.

Wanted—Machine-shop foreman wanted to take full charge of all vise work (small high grade interchangeable parts) in large manufacturing plant; must be thoroughly able to get the maximum amount of work out at a minimum cost; very good opportunity for the right man; state qualifications, salary expected, and references. Box 362, AM. MACH.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

VIRGINIA

Salesman—We wish to engage a good, live man having knowledge of the machinery and supply business; one familiar with the trade in North and South Carolina preferred. Address Box 335, AMERICAN MACHINIST.

WISCONSIN

Wanted—For accurate gear cutting, a competent man who will instruct and supervise, also operate machines on automobile work; open shop; good surroundings Thomas B. Jeffery & Company, Kenosha, Wis.

Large concern building exeavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

WEST OF MISSISSIPPI

The J. Geo. Leyner Eng. Wks. Co., of Littleton, Colo., are increasing their plant and are in need of good mechanics, machinists, blacksmiths and sheet-iron workers. Littleton is a suburb of Denver, where cost of living is reasonable; superb climate the year round. Address above.

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Norton Co., Worcester, Mass.
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Wilmarth & Morman Co., Grand Rapids, Mich.

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Dodge & Day, Philadelphia, Pa.

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National Machinery Co., Tiffin, O.

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See Roller Bearings.

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Baird Machine Co., Oakville, Ct.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Niles-Bement-Pond Co., New York.

Bars, Boring—*Continued.*

Prentiss Tool & Supply Co., New York.

Belt Dressing

Dixon Crucible Co., Joseph, Jersey City, N. J.
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Belt Filler

Schieren & Co., Chas. A., New York.
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Wallace Supply Co., Chicago, Ill.

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See Hoists, Hand.

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General Electric Co., New York.
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Bolt and Nut Machinery

Acme Machry. Co., Cleveland, O.
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Boynton & Plummer, Worcester, Mass.
Davis Machine Co., W. P., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Foote, Burt & Co., Cleveland, O
Harrington & Son Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.

Bolt and Nut Machinery—*Continued.*

Northern Elec. Mfg. Co., Madison, Wis.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Machinery Co., Bowling Green, Ohio.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Yost Co., G. M., Waynesboro, Pa.

Bolt Heads

Lang Co., G. R., Meadville, Pa.

Bolts, Coupling

National-Acme Mfg. Co., Cleveland, O.

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National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening

Davidge & Co., W. M., New York.

Books, Mechanical

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
Sames, C. M., Jersey City, N. J.
Wiley & Sons, Jno., New York.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. & Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.

Boosters—*Continued.*
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Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
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Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
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Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Wks., Philadelphia, Pa.
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Pawling & Harnischfeger, Milwaukee, Wis.
Prentiss Tool & Supply Co., New York.
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Baker Bros., Toledo, O.
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Colburn Mach. Tool Co., Franklin, Pa.
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Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
King Mach. Tool Co., Cincin., O.
McCabe, J. J., New York.
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Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.

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Armstrong Bros. Tool Co., Chicago, Ill.

Brackets, Lamp
Standard Welding Co., Cleveland, Ohio.

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Prentiss Tool & Supply Co., New York.

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Armstrong Bros. Tool Co., Chicago, Ill.
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Hammacher, Schlemmer & Co., New York.

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Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams
Boston Gear Wks., Boston, Mass.

Carborundum
See Grinding Wheels.

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Lumen Bearing Co., Buffalo, N. Y.
Nolte Brass Co., Springfield, Ohio.
Phosphor Bronze Smelting Co., Phila., Pa.

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Franklin Mfg. Co., H. H., Syracuse, N. Y.

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Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Hopson & Chapin Mfg. Co., New London, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.
Veeder Mfg. Co., Hartford, Conn.

Castings, Malleable
Bancroft & Co., Philadelphia, Pa.

Castings, Steel
Bancroft & Co., Philadelphia, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.
New England Steel Casting Co., Hyde Park, Mass.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Hendey Mach Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Machine Co., D. E., New London, Conn.

Centers, Planer
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
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Baldwin Chain & Mfg. Co., Worcester, Mass.
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Jeffrey Mfg. Co., The, Columbus, Ohio.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
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Warner & Swasey Co., Cleveland, Ohio.
Whitcomb - Blaisdell Mach. Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell - Pratt Co., Greenfield, Mass.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Scott & Sons Co., Medford, Mass.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split
National Tool Co., Cleveland, O.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers
Crocker - Wheeler Co., Ampere, N. J.
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Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.

Clutches, Friction
Caldwell, Son & Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Wood's Sons Co., T. B., Chambersburg, Pa.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Coils
Standard Welding Co., Cleveland, Ohio.

Compound, Pipe Joint
Dixon Crucible Co., Jos., Jersey City, N. J.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Boston, Mass.
Bury Compressor Co., Erie, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Mietz, August, New York.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Ingersoll-Rand Co., New York.

Condensers
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
Evans Friction Cone Co., Boston, Mass.

Connecting Rods and Straps
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Mach. Co., Boston, Mass.
Chapman & Co., J. B., Springfield, Mass.

Controllers and Starters, Electric Motor
Case Mfg. Co., Columbus, Ohio.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.

Controllers and Starters, Electric Motor—*Continued.*
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Coping Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Cork Inserts
National Brake & Clutch Co., Boston, Mass.

Correspondence Schools
See Schools, Correspondence.

Cotters
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders' Iron Fdry., Prov., R. I.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Cresson Co., Geo. V., Phila., Pa.
Gisholt Mach. Co., Madison, Wis.
Speed Changing Pulley Co., Indianapolis, Ind.

Counting and Printing Wheels
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose
Ingersoll-Rand Co., New York.

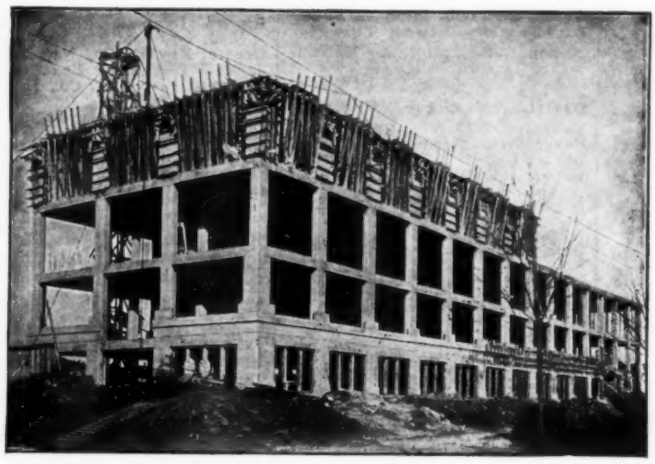
Couplings, Shaft
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cresson Co., Geo. V., Phila., Pa.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkesbarre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes
Alliance Machine Co., Alliance, O.
Brown Hoisting Mach. Co., New York.
Case Mfg. Co., Columbus, O.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

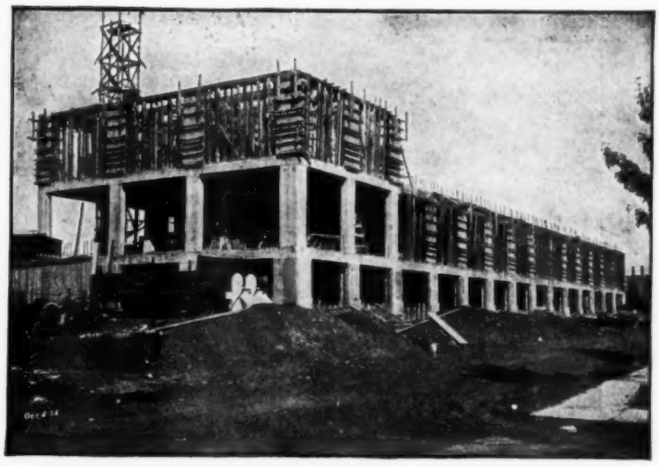
Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.

Crank Shafts
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

NOVEMBER 1st, 1906.

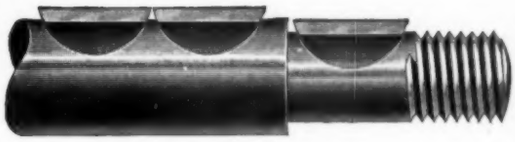


OCTOBER 1st, 1906.



AUGUST 1st, 1906.

This will be Headquarters for HIGH-GRADE DRIVING CHAINS, THE WOODRUFF PATENT SYSTEM OF KEYING and HAND (FEED) MILLING MACHINES.



We will commence to move into our new fire-proof factory building this month and will operate both plants, old and new, until we are fully settled in our new quarters, so our production will not be decreased.

The Whitney Mfg. Co.,

Hartford,

Connecticut.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups, Grease
Lunkenheimer Co., Cincinnati, O.

Cut Meters
Warner Instrument Co., Beloit, Wis.

Cutters, Milling
Adams Co., Dubuque, Iowa.
Becker - Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Ingersoll Milling Mach. Co., Rockford, Ill.
International High Speed Steel Co., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Fawcus Mach. Co., Pittsburg, Pa.
Hill, Clarke & Co., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Machine Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Cutting-Off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.

Diamond Tools
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Boston Tool Co., Cambridge, Mass.
Kent & Co., Edwin R., Chicago, Ill.
Wade Machine Co., Boston, Mass.

Dies, Sub-Press
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Mach. Co., Springfield, Vt.
Modern Tool Co., Erie, Pa.
Pratt & Whitney Co., Hartford, Conn.
Scott & Sons Co., Medford, Mass.

Dowel Pins
Winkley Co., Hartford, Conn.

Drawing Boards and Tables
Keuffel & Esser Co, New York.
Obermayer Co., S., Cincinnati, O.
Rich, J. & G., Philadelphia, Pa.

Drawing Materials
Rich, J. & G. Philadelphia.
Soltmann, E. G., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drift Bolt Drivers
Ingersoll-Rand Co., New York.

Drilling Machines, Bench
American Watch Tool Co., Waltham, Mass.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Dwight Slate Machine Co., Hartford, Conn.
Goodell - Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote, Burt & Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fairbanks Co., New York.
Fitchburg Machine Works, Fitchburg, Mass.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
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Harrington, Son & Co., Edwin, Philadelphia, Pa.
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Sellers & Co., Inc., Wm., Philadelphia, Pa.
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Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.

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Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

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General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
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Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
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Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Curtis & Curtis Co., Bridgeport, Conn.
Hisey-Wolf Mach. Co., Cincin., O.
Parker Co., Chas., Meriden, Conn.
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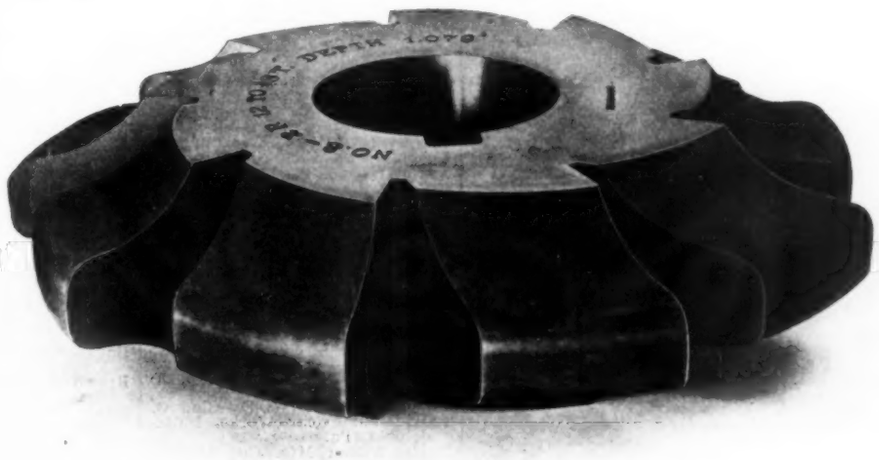

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Westmacott, J. M., Prov., R. I.

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Bristol Co., Waterbury, Conn.

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Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
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Sloan & Chace Mfg. Co., Newark, N. J.
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Morse Twist Drill & Mach. Co., New Bedford, Mass.

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Bilgram, Hugo, Philadelphia, Pa.
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Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
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Earle Gear & Mach. Co., Philadelphia, Pa.
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Fawcus Mach. Co., Pittsburg, Pa.
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New Process Rawhide Co., Syracuse, N. Y.
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Patterson, Gottfried & Hunter, Ltd., New York.
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Sawyer Gear Wks., Cleveland, O.
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Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
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Woburn Gear Works, Woburn, Mass.

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Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Walcott & Son, Geo. D., Jackson, Mich.

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Chicago Raw Hide Mfg. Co., Chicago, Ill.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
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Safety Emery Wheel Co., Springfield, O.

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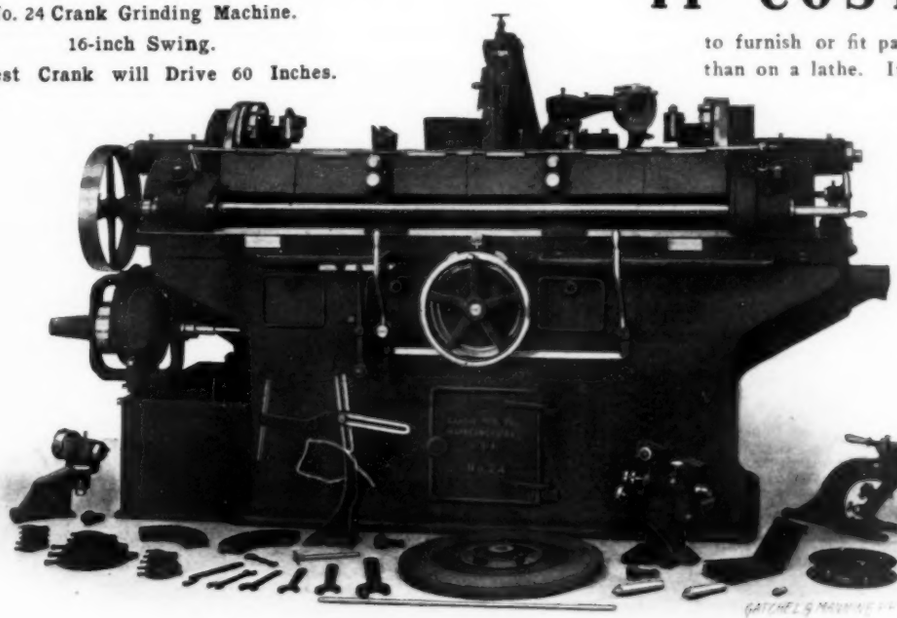

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Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Scranton & Co., New Haven, Ct.

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Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Handles, Machine Tool

Cincinnati Ball Crank Co., Cincinnati, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Hangers, Shafting

Cresson Co., Geo. V., Phila., Pa.
Link-Belt Co., Philadelphia, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Heaters, Feed Water

Sturtevant Co., B. F., Hyde Park, Mass.

Heating and Ventilating Apparatus

Boston Blower Co., Hyde Park, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Heating Machines

Am. Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Hoisting and Conveying Machinery

Alliance Machine Co., Alliance, O.
Brown Hoisting Machinery Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Caldwell & Son Co., H. W., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Cresson Co., Geo. V., Phila., Pa.
Jeffrey Mfg. Co., Columbus, O.
Lamson Consolidated S. S. Co., Boston, Mass.
Link-Belt Co., Philadelphia, Pa.
Main Belting Co., Phila., Pa.
Niles-Bement-Pond Co., New York.
United Engineering & Fdry. Co., Pittsburg, Pa.

Hoists, Electric

C & C Electric Co., New York.
Case Mfg. Co., Columbus, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crocker - Wheeler Co., Ampere, N. J.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Electric Co., New York.
General Pneu. Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Sprague Electric Co., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Hand

Case Mfg. Co., Columbus, O.
Chisholm & Moore Mfg. Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic

Chisholm & Moore Mfg. Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneu. Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit, Mich.

Hose, Steel

Sprague Electric Co., New York.

Igniters, Gas Engine

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Indicators, Speed

Niagara Tachometer & Inst. Co., Niagara Falls, N. Y.
Starrett Co., L. S., Athol, Mass.

Indicators, Speed, Peripheral

Warner Instrument Co., Beloit, Wis.

Indicators, Test

Norton Co., Worcester, Mass.

Industrial Railways

Hunt Co., C. W., West New Brighton, N. Y.

Injectors

International Specialty Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Inspection and Tests

Hunt Co., Robert W., Chicago, Ill.

Instruction Schools

See Schools, Correspondence.

Instruments, Electric

General Electric Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.

Jacks, Hydraulic

Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Watson-Stillman Co., New York.

Jacks, Planer

Armstrong Bros. Tool Co., Chicago, Ill.

Kettles, Soda

Brown & Sharpe Mfg. Co., Providence, R. I.
Mfg. Equip. & Eng. Co., E. Boston, Mass.

Key Seaters

Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Chattanooga Machry. Co., Chattanooga, Tenn.
Hill Standard Mfg. Co., Anderson, Ind.
Marshall & Huschart Machry. Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Whitney Mfg. Co., Hartford, Ct.

Keys, Machine

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Gauge Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Ct.

Knurls

Hammacher, Schlemmer & Co., New York.

Lamps, Arc

General Electric Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lamps, Incandescent

General Electric Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathe Attachments

American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bradford Machine Tool Co., Cincinnati, O.
Fitchburg Machine Works, Fitchburg, Mass.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe Mfg. Co., Boston, Mass.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Sloan & Chace Mfg. Co., Newark, N. J.

Lathe Dogs

Armstrong Bros. Tool Co., Chicago, Ill.
Besly & Co., Chas. H., Chicago, Ill.
Hill Standard Mfg. Co., Anderson, Ind.
LeCount, Wm. G., So. Norwalk, Conn.
Pratt & Whitney Co., Hartford, Conn.
Tindel-Morris Co., Eddystone, Pa.

Lathes

American Tool Works Co., Cincinnati, O.
Automatic Mach. Co., Bridgeport, Conn.
Barnes Co., W. F. & John, Rockford, Ill.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Blount Co., J. G., Everett, Mass.
Bradford Mach. Tool Co., Cin., O.
Bullard Mach. Tool Co., Bridgeport, Conn.
Champion Tool Works Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Diamond Machine Co., Providence, R. I.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Garvin Mach. Co., New York.
Gisholt Mach. Co., Madison, Wis.
Greaves, Klusman & Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hendey Mach. Co., Torrington, Conn.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mach. Tool Co., Cincinnati, O.
McCabe, J. J., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Ridgway Mach. Tool Co., Ridgway, Pa.
Robbins, L., Worcester, Mass.
Schumacher & Boye, Cincinnati, Ohio.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Springfield Mach. Tool Co., Springfield, O.
Tindel-Morris Co., Eddystone, Pa.
Towsley Mfg. Co., J. T., Cincinnati, O.
Vandyck Churchill Co., New York.
Von Wyck Mach. Tool Co., Cincinnati, O.
Walcott & Son, Geo. D., Jackson, Mich.
Wells & Sons Co., F. E., Greenfield, Mass.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.
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American Watch Tool Co., Waltham, Mass.
Blount Co., J. G., Everett, Mass.
Fenn Mach. Co., Hartford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett Lathe Mfg. Co., Boston, Mass.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stark Tool Co., Waltham, Mass.
Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Springfield, Mass.
Waltham Watch Tool Co., Springfield, Mass.

Lathes, Boring
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Lathes, Brass
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Dreses Mach. Tool Co., Cincin., O.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Springfield Mch. Tool Co., Springfield, O.
Windsor Mach. Co., Windsor, Vt.

Lathes, Extension
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Prentiss Tool & Supply Co., New York.

Lathes, Foot Power
Barnes Co., W. F. & Jno., Rockford, Ill.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Lathes, Speed
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Blount Co., J. G., Everett, Mass.

Lathes, Wood
Prentiss Tool & Supply Co., New York.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Letters, Pattern
Butler, A. G., New York.

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Starrett Co., L. S., Athol, Mass.

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Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Locks
Yale & Towne Mfg. Co., New York.

Locomotives, Electric
General Electric Co., New York.

Lubricants
Besly & Co., Chas. H., Chicago, Ill.
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Lubricators
Besly & Co., Chas. H., Chicago, Ill.

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Baird Machry. Co., Pittsburg, Pa.
Chandler & Farquhar Co., Boston, Mass.
Garvin Mach. Co., New York.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Motch & Merryweather Co., Cleveland, O.
Niles-Bement-Pond Co., New York.

Machinery Dealers—*Cont*
Patterson, Gottfried & Hunter, Ltd., New York.
Prentiss Tool & Supply Co., New York.
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Vandyck Churchill Co., New York.
Wormer Mach. Co., C. C., Detroit, Mich.

Machinists' Small Tools
Athol Machine Co., Athol, Mass.
Bemis & Call Hardware & Tool Co., Springfield, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Hammacher, Schlemmer & Co., New York.
Kendrick & Davis, Lebanon, N. H.
Le Count, Wm. G., So. Norwalk, Conn.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.

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Frasse Co., Peter A., New York.
Hammacher, Schlemmer & Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Mandrels, Expanding
Nicholson & Co., W. H., Wilkesbarre, Pa.

Mandrels, Solid
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Schellenbach & Darling Tool Co., Cincinnati, O.
Standard Tool Co., Cleveland, O.
Wells Bros. Co., Greenfield, Mass.

Marking Machines
Slate Machine Co., Dwight, Hartford, Conn.

Measuring Machines
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.

Mechanical Draft
Boston Blower Co., Hyde Park, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.

Metal, Bearing
Besly & Co., Chas. H., Chicago, Ill.
Lumen Bearing Co., Buffalo, N. Y.
Phosphor Bronze Smelting Co., Phila., Pa.

Meters, Electric
General Electrical Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.

Micrometer Calipers
Brown & Sharpe Mfg. Co., Providence, R. I.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Milling Attachments
Adams Co., Dubuque, Iowa.
American Watch Tool Co., Waltham, Mass.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Burke Machinery Co., Cleveland, Ohio.
Cincinnati Milling Machine Co., Cincinnati, O.
Kempsmith Mfg. Co., Milwaukee, Wis.
Niles-Bement-Pond Co., New York.

Milling Attachments—*Continued.*
Rivett Lathe Mfg. Co., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Milling Machines, Bench
American Watch Tool Co., Waltham, Mass.
Niles-Bement-Pond Co., New York.
Rivett Lathe Mfg. Co., Boston, Mass.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Hand
Brown & Sharpe Mfg. Co., Providence, R. I.
Prentiss Tool & Supply Co., New York.
Whitney Mfg. Co., Hartford, Ct.

Milling Machines, Horizontal
Beaman & Smith Co., Prov., R. I.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Cincinnati Milling Machine Co., Cincinnati, O.
Hendey Mach. Co., Torrington, Ct.
Hess-Bright Mfg. Co., Phila., Pa.
Ingersoll Milling Mach. Co., Rockford, Ill.
Kempsmith Mfg. Co., Milwaukee, Wis.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Milling Machines, Plain
Adams Co., Dubuque, Iowa.
American Tool Wks. Co., Cin., O.
Beaman & Smith Co., Prov., R. I.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Conn.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Owen Mach. Tool Co., Springfield, Ohio.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Vanderbeek Tool Wks., Hartford, Conn.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.
Whitney Mfg. Co., Hartford, Ct.

Milling Machines, Universal
American Tool Wks. Co., Cin., O.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Garvin Mach. Co., New York.
Hendey Mach. Co., Torrington, Conn.
Kempsmith Mfg. Co., Milwaukee, Wis.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Owen Mach. Tool Co., Springfield, Ohio.
Prentiss Tool & Supply Co., New York.
Vanderbeek Tool Wks., Hartford, Conn.
Vandyck Churchill Co., New York.
Waltham Watch Tool Co., Springfield, Mass.

Milling Machines, Vertical
Adams Co., Dubuque, Iowa.
Beaman & Smith Co., Prov., R. I.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.

Milling Machines, Vertical—*Continued.*
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Garvin Mach. Co., New York.
Ingersoll Milling Mach. Co., Rockford, Ill.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Owen Mach. Tool Co., Springfield, Ohio.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Milling Tools, Adjustable
Geometric Tool Co., New Haven, Conn.
Rogers Works, John M., Gloucester City, N. J.

Mining Machinery
Ingersoll-Rand Co., New York.

Mixing and Shifting Machines, Sand
Gould & Eberhardt, Newark, N. J.
Link-Belt Co., Philadelphia, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Molding Machines
Adams Co., Dubuque, Iowa.
Mumford Co., E. H., Phila., Pa.
Tabor Mfg. Co., Phila., Pa.

Mortising Machines, Chain
New Britain Mach. Co., New Britain, Conn.

Motors, Electric
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker - Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
Eck Dynamo & Motor Wks., Belleville, N. J.
Electro Dynamic Co., Bayonne, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Lamb Electric Co., Grand Rapids, Mich.
Northern Electrical Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Name Plates
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Turner Brass Works, Chicago, Ill.

Nozzles, Sand and Air
Lunkenheimer Co., Cincinnati, O.
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See Bolt and Nut Machinery.

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Oil Stones
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike Station, N. H.

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Ekert High Resistance Materials Co., Dayton, O.
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Felton, Sibley & Co., Philadelphia, Pa.

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Rowbottom Machine Co., Waterbury, Conn.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Whitcomb - Blaisdell Mach. Tool Co., Worcester, Mass.

Pencils
Dixon Crucible Co., Jos., Jersey City, N. J.

Phosphor Bronze
Lumen Bearing Co., Buffalo, N. Y.
Phosphor Bronze Smelting Co., Philadelphia, Pa.

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Gould & Eberhardt, Newark, N. J.

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Prentiss Tool & Supply Co., New York.
Saunders Sons, D., Yonkers, N. Y.
Standard Engineering Works, Ellwood City, Pa.
Stoever Fdry. & Mfg. Co., Meyerstown, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

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Cleveland Twist Drill Co., Cleveland, O.
Saunders Sons, D., Yonkers, N. Y.
Standard Tool Co., Cleveland, O.

Planer Attachments
Cincinnati Planer Co., Cincin., O.
Gray Co., G. A., Cincinnati, O.

Planers
American Tool Wks. Co., Cin., O.
Bartlett, E. E., Boston, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Cincinnati Planer Co., Cincin., O.
Cleveland Planer Works, Cleveland, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Garvin Mach. Co., New York.
Gray Co., G. A., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hendey Mach. Co., Torrington, Conn.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Ridgway Mach. Tool Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Towsley Mfg. Co., John T., Cincinnati, O.
Vandyck Churchill Co., New York.
Whitcomb - Blaisdell Mach. Tool Co., Worcester, Mass.
Woodward & Powell Planer Co., Worcester, Mass.

Planers, Portable
Niles-Bement-Pond Co., New York.

Planers, Rotary
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

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Precision Machinery
American Watch Tool Co., Waltham, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Stark Tool Co., Boston, Mass.

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Prentiss Tool & Supply Co., New York.
Watson-Stillman Co., New York.

Presses, Drop
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.

Presses, Foot and Hand
Bliss Co., E. W., Brooklyn, N. Y.

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Wiley & Son, John, New York.

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Caldwell & Son Co., H. W., Chicago, Ill.
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Rockwood Mfg. Co., Indianapolis, Ind.
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Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.

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General Electric Co., New York.

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Sellers & Co., Inc., Wm., Philadelphia, Pa.

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American Gas Furnace Co., New York.

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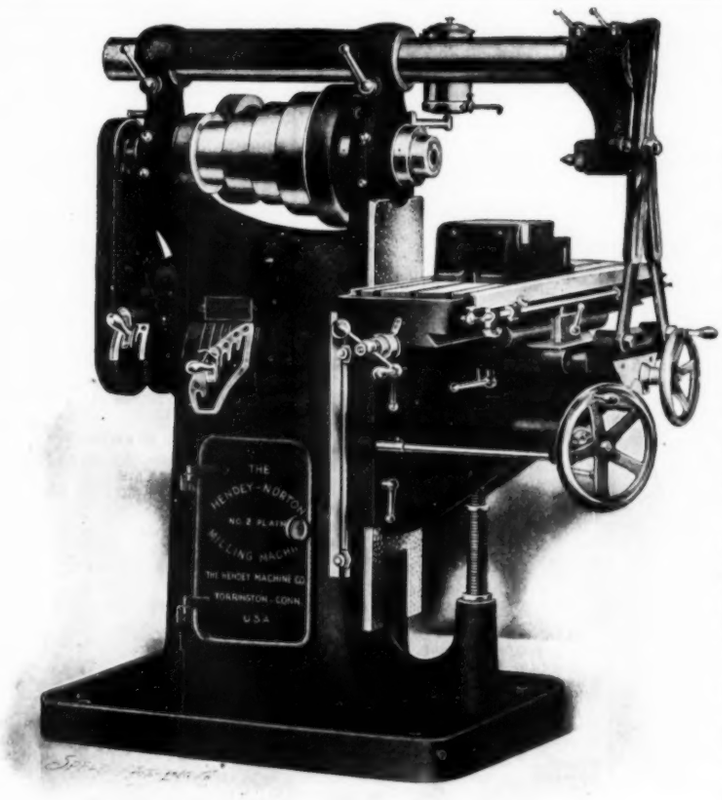

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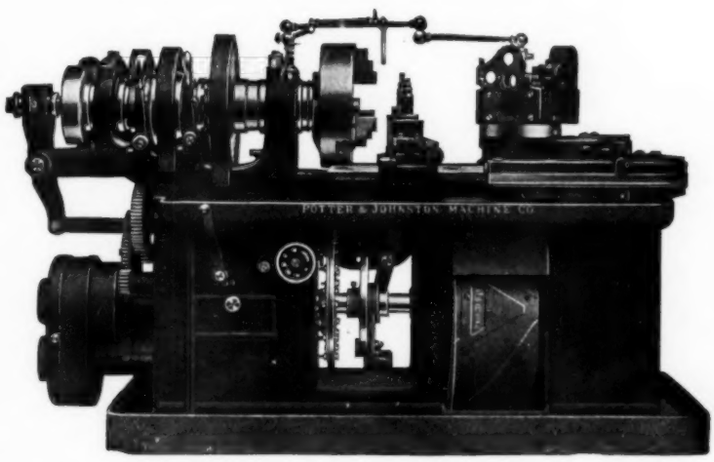

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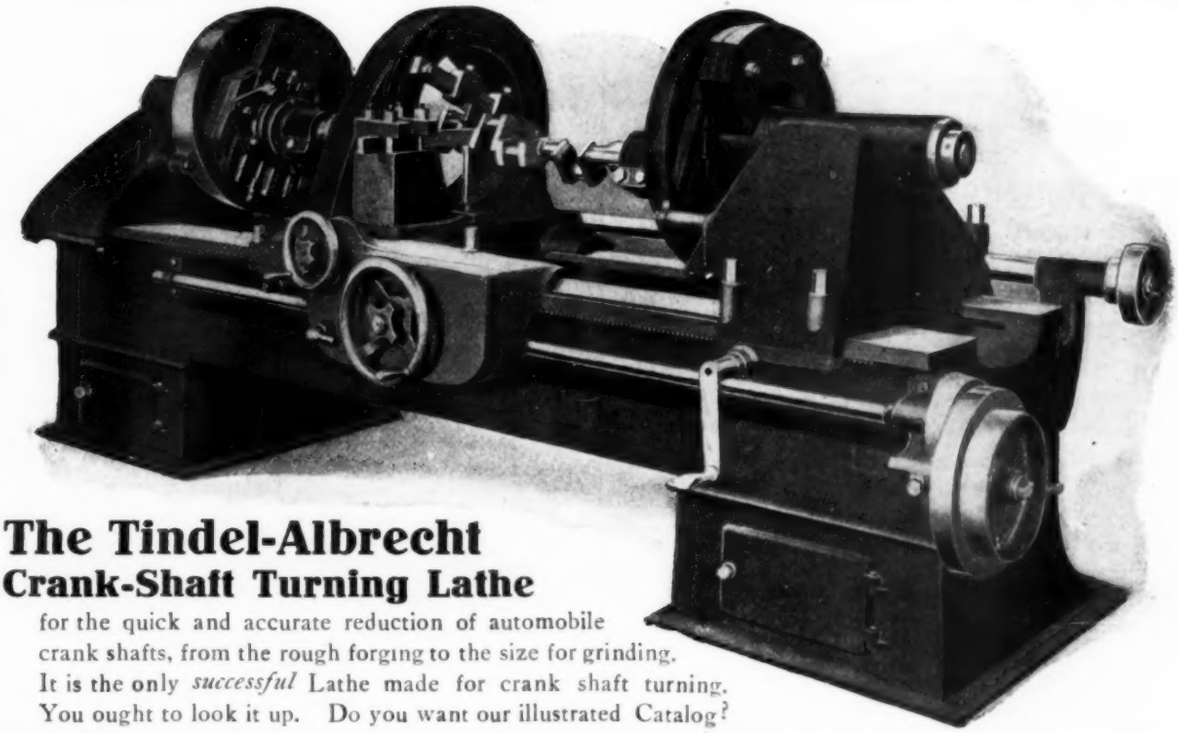

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Wells Bros. Co., Cleveland, O.
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Geometric Tool Co., New Haven, Conn.
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Rogers Telephone & Electric Co., Danbury, Conn.

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United Engineering & Fdry. Co., Pittsburg, Pa.

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Hill Standard Mfg. Co., Anderson, Ind.
O. K. Tool Holder Co., Shelton, Conn.
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Tools, Small
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Cresson & Co., Geo. V., Phila., Pa.
Link-Belt Co., Philadelphia, Pa.
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Rockwood Mfg. Co., Indianapolis, Ind.
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Springfield Mach. Tool Co., Springfield, O.
Warner & Swasey Co., Cleveland, Ohio.
Wells & Sons Co., F. E., Greenfield, Mass.
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Windsor Mach. Co., Windsor, Vt.

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Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
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Standard Tool Co., Cleveland, O.
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Whitman & Barnes Mfg. Co., Chicago, Ill.
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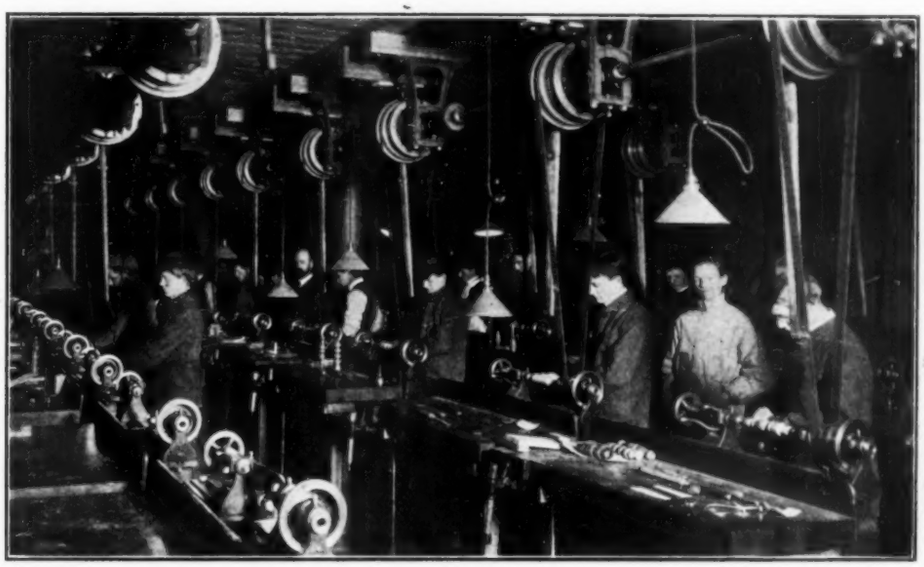

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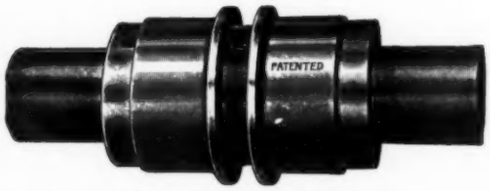

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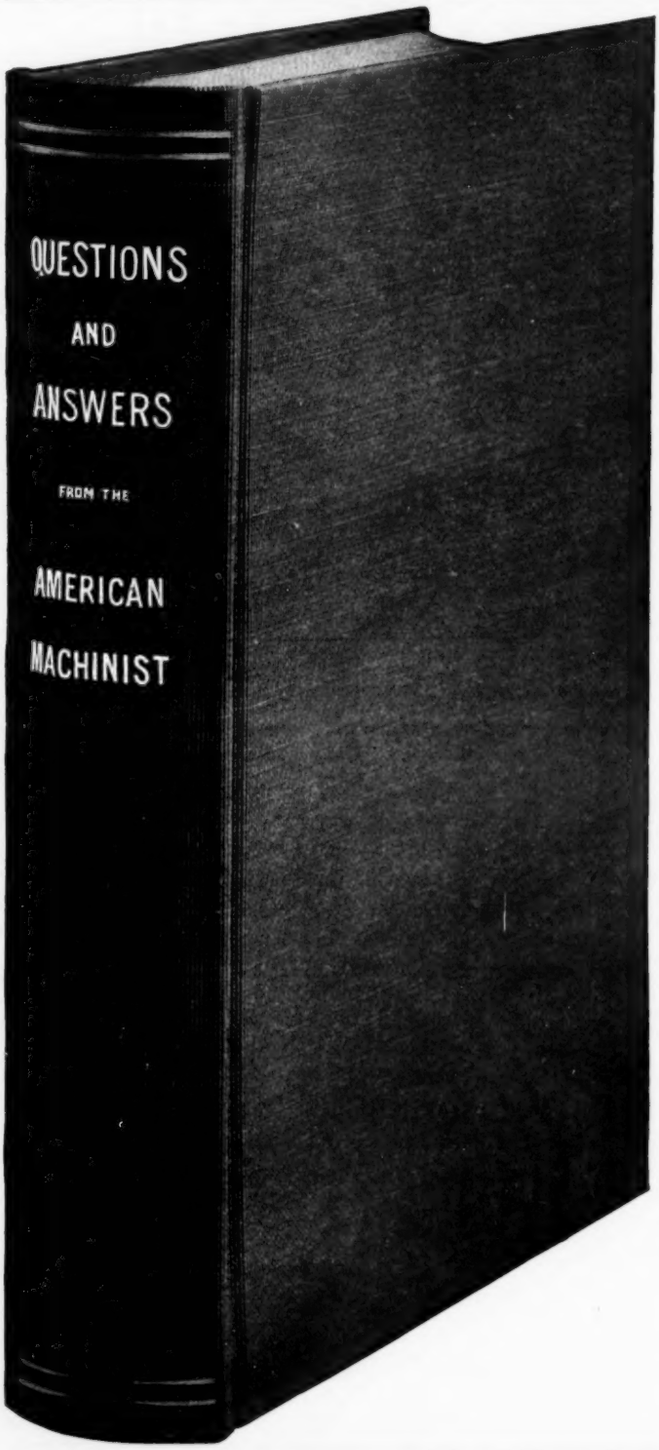

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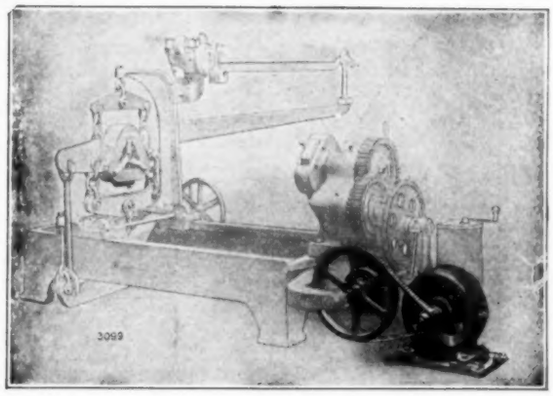

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1—No. 3 Burke Hand.
1—No. 4 Burke Hand.
1—No. 2 Fox Hand.

SHAPERS.

2—14" Gould & Eberhardt Crank.
1—16" Gould & Eberhardt Crank.
2—16" Steptoe Crank.
1—26" Juengst Friction.

BORING AND TURNING MILLS.

4—42" Rogers 2 Heads.
1—44" Rogers 2 Heads.
1—62" Rogers 2 Heads.
1—48"Colburn 2 swivel heads 3 jaw chuck.
1—48" Colburn 2 swivel heads plain table.
1—48" Colburn 1 swivel head 1 swivel turret head, 3 jaw head power rapid transverse for both heads.
1—7' Poole 2 Heads.

PRESSES.

1—No. 0 V. & O. Power.
2—No. 1 Hibbard Power.
1—No. 8 Hibbard Power.
2—No. 2½ V. & O. Power.
1—No. 2 Greenerd Arbor.
4—No. 3 Greenerd Arbor.
2—No. 3½ Greenerd Arbor.

DRILLS.

1—21" Cincinnati W. & L.
1—26" Barnes Staty. Head Complete.
1—31" Barnes Slid. Head Complete.
2—No. 1 Bickford Improved Plain Radial with Plain Table.
1—No. 2 Bickford Improved Plain Radial with Plain Table.
1—Style M. I. Baker Bros. 11 in. feed tapping.
1—Style F. Baker Bros. 8 in. feed tapping.
1—4 spindle Gardam Rail.
1—8 spindle Gardam Adjustable Spindle, also one, two and three-spindle sensitives.

MISCELLANEOUS.

1—25 lb. Scranton Power.
2—350 lb. Bell Steam.
1—850 lb. Bell Steam.
1—No. 2—4 in. Williams Pipe Machine.
1—No. 7 2 in. Jarecki Pipe Machine.
1—No. 3 Merriman Bolt Cutter.
1—2" Reliance Bolt Cutter.
1—3" Davis Cutting Off Machine.
2—10 B. Besly Disc Grinders.

PRENTISS TOOL & SUPPLY CO.,
New York, Buffalo, Boston, Syracuse.